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MANUFACTURE OF SAVAGE 0.22 CALIBER HIGH-POWER RIFLE—2

INTERESTING MACHINING OPERATIONS ON VARIOUS RIFLE PARTS—SPECIAL MACHINES AND FIXTURES USED AT FACTORY OF SAVAGE ARMS CO.

BY FRANKLIN D. JONES*

IN the manufacture of a Savage rifle such as the 0.22 caliber high-power type, 815 operations are necessary. To handle this amount of work and at the same time produce a high-grade rifle which can be sold at current prices is a striking illustration of what can be accomplished with modern tools backed by efficient and systematic manufacturing methods. In the preceding installment of this article (published in the July number) the action for the 0.22 caliber high-power rifle was described, and the manufacturing and inspection systems employed at the factory of the Savage Arms Co. were referred to in a general way. In the present article reference will be made to some of the more important operations on various rifle parts.

Machining a Rifle Barrel

The barrel for a Savage high-power rifle is made of alloy steel of special composition to withstand the enormous pressure to which it is subjected. This pressure, in the case of the 0.22 caliber high-power rifle, is approximately 48,000 pounds per square inch at the instant of discharge. The barrel, after being centered, is rough-turned tapering in an ordinary lathe equipped with a follow-rest. This roughing operation is for removing most of the outer stock, thus relieving the barrel of any strains which might exist in or near the outer surfaces. The barrel is then drilled in a Pratt & Whitney drilling machine, as will be described later. There are two additional turning operations on the barrel after the hole is drilled, one being a second roughing cut and the other a finishing cut.

Fig. 1. An Example of Artistic Carving and Engraving on a Savage Rifle

One of the special lathes used for these turning operations is shown in Fig. 2. The barrel is supported by a three-roller back-rest *A* carried by the large bracket *B* extending along the bed at the rear. This roller-rest remains in a central position with relation to the barrel being turned, and the tool is guided by an attachment which operates on the principle of an ordinary taper attachment; that is, the cross-slide carries a bar and roller which bears against a former at the rear, curved to correspond with the shape required for the barrel. (The octagonal barrels used on the smaller rifles are gang milled, several being held at a time in multiple index centers set to give the required taper.) When taking the finishing cut over the barrel, the mark which is sometimes left by a roller-rest is prevented in the following manner: The central bearing for the roller-rest is turned down a few thousandths larger than the required size, and the tool, when taking the finishing cut is automatically stopped when it reaches this roller-rest spot. The cut is then started on the opposite side and the turning continued. The spot is finally removed in the polishing department on a leather-faced polishing wheel.

Drilling a Rifle Barrel

One of the most delicate operations in rifle manufacture is that of machining the hole through the barrel. To drill a straight hole 0.22 inch in diameter through twenty inches of tough alloy steel is a job that requires the right tool and the right machine. The drilling machines used are of a duplex type, two barrels being operated on at the same time. A detail view of one of the barrel drilling machines used at the Savage factory is shown in Fig. 3. The barrels *A* revolve and the drills *B* remain stationary, except for the feeding movement. This is in accordance with the well-known principle of deep-hole drilling. When the drill revolves, a slight deviation from the true course tends to increase, but when a rotary motion is given to the work instead of to the drill, if the drill point varies from its central position, it will be carried around in a small circle and, consequently, the drill shank will be bent in various directions. The result of this bending action tends to force the drill point back to the course of least resistance, which is along the axis about which the work revolves; therefore, because of this tendency, the drill follows a true course if all conditions are favorable.

First, the drill must be properly ground; moreover it must be guided by a close-fitting bushing when starting the hole and the hole must be kept clear of chips. The drills are supported in brackets *C* attached to the base of the machine, and they are started true by passing them through bushings which fit over the turned ends of the barrels. The drill used

* Associate Editor of MACHINERY.

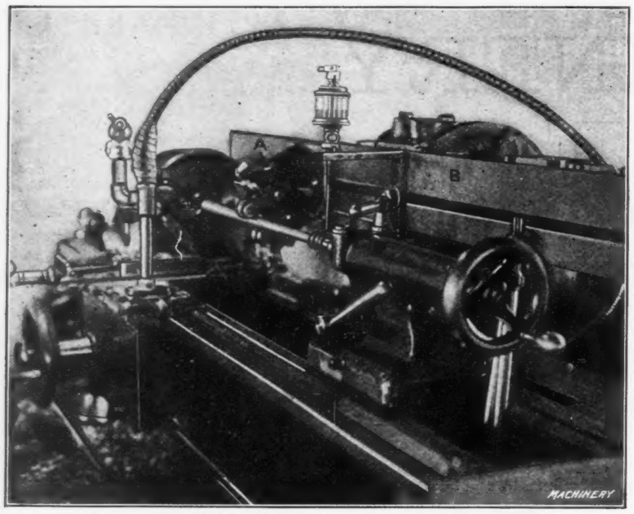

Fig. 2. Special Lathe used for turning Rifle Barrels

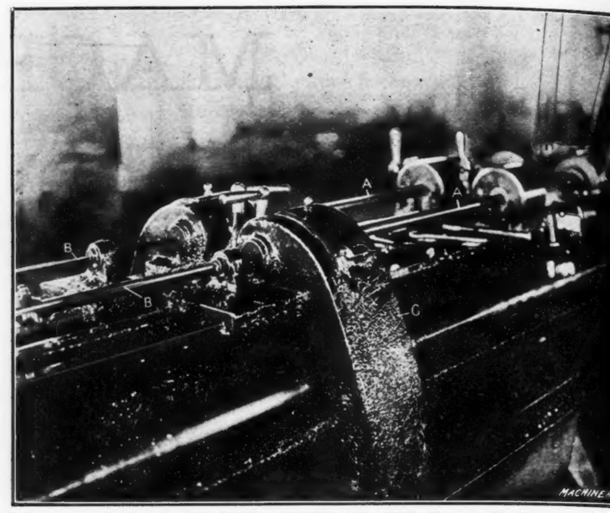

Fig. 3. Detailed View of Pratt & Whitney Rifle Barrel Drilling Machine

for this work has one straight flute and one cutting edge. Back of the cutting edge there is a section that is practically straight, which supports the cutting end so that the hole itself form a bushing as the drill feeds through the barrel. The drill tip is from four to eight inches long and is held at the end of a tube or shank. The lubricant is forced through this shank and also through a duct passing through to the drill point. As the pressure of the lubricant is about 200 pounds per square inch, the chips are forced back along the straight flute with the lubricant.

The feed of the drill per revolution of the barrel, for drilling a 0.22 caliber rifle, is about 0.0025 inch per revolution of the work. The speed at which the barrel rotates depends upon the material and the size of the bore, varying from 1500 to 2400 revolutions per minute. When the hole is drilled, a trip automatically shifts the driving belt and stops the machine. The hole is drilled to within 0.005 inch of the finished diameter.

Reaming the Barrel Hole

The next operation on the bore is that of reaming, in order to finish the hole to the exact diameter required. The reaming is done in a machine which is duplex but differs from the drilling machine in that the reamers are revolved slowly by the machine spindles while the barrels feed over them and remain stationary except for the feeding movement. Two kinds of reamers are used: The first is a cutting reamer and its cross-sectional shape is shown by the enlarged view at *A*, Fig. 5. This type of reamer removes about 0.003 inch; the remaining 0.002 inch is then removed by a scraping reamer, the shape of which is shown at *B*. The tops of the teeth of this scraping reamer are ground and stoned to form sharp ridges which take very light scraping cuts and leave a "mirror finish" in the bore of the rifle.

The number of times these cutting and scraping reamers have to be passed through the bore depends upon the caliber. After the first reaming operation, the accuracy of the bore is tested by dropping through it a close-fitting plug eight inches long. If this passes through without being forced, it shows that the barrel is straight within very close limits. The accuracy of the bore is also tested by holding the barrel in line with a narrow strip placed across a ground glass in one of the windows. By sighting through the bore on this strip and then turning the barrel, any inaccuracy will be shown by the movement of the shadows of the strip reflected along the sides of the bore. (This method was described and illustrated in an article entitled "The Ross Rifle and its Manufacture," published in the November, 1911, number of MACHINERY.)

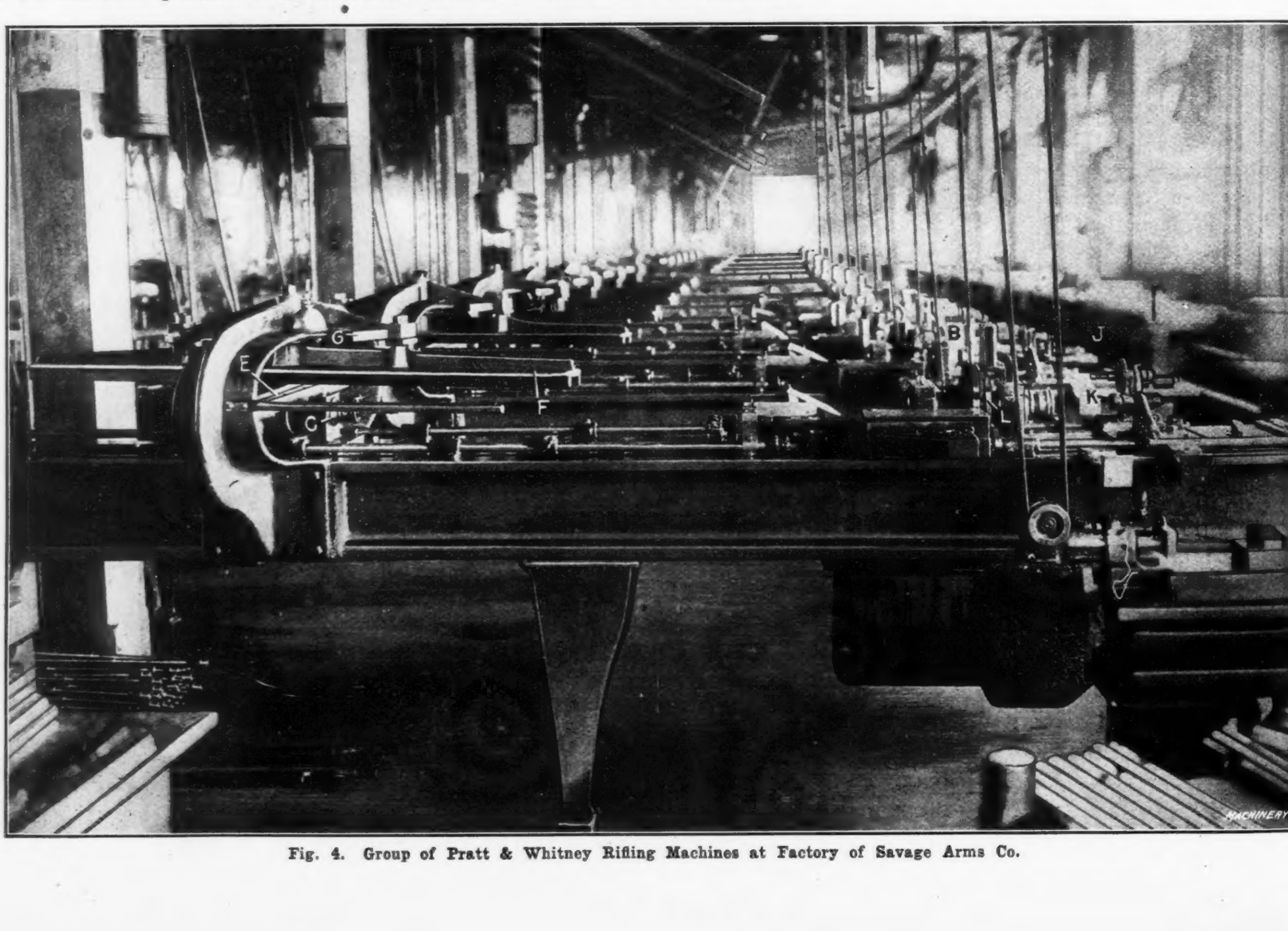

Fig. 4. Group of Pratt & Whitney Rifling Machines at Factory of Savage Arms Co.

Rifling the Barrel

Helical or spiral grooves are cut in the barrels of all modern firearms to impart a rotary motion to the bullet, as is generally known. This rotary motion causes the axis of an accurately made bullet to keep in a line with its flight or trajectory, which increases the range, accuracy, and penetration. Experiments have demonstrated that the mean deviation of the shots fired from a rifled gun at medium ranges is only one-third that from a smooth bore, when all known and controllable causes of deviation have been eliminated.

In the Savage 0.22 caliber high-power rifle, there are six of these rifling grooves which have a pitch or lead of twelve

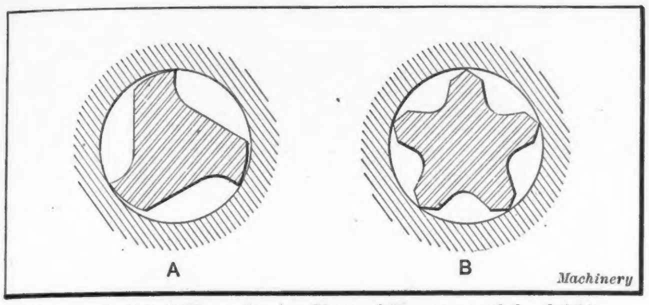

Fig. 5. Sectional Views showing Shape of Reamers used for finishing the Bores of Rifle Barrels

inches, this being the distance that the grooves advance in one turn. The cutting of these grooves, which are only 0.003 inch deep and 0.065 inch wide, is a very interesting operation. Pratt & Whitney rifling machines are used. A group of these machines is shown in Fig. 4. The operation, briefly described, is as follows: The rifle barrel is held in an indexing head *B* and remains stationary except when indexing from one groove to the next. The grooves are cut by a small tool, the cutting edge of which corresponds to the shape of the groove required. This tool is carried in a tool-head screwed to a long shank which is gripped by chuck *C*. This chuck, in turn, is carried by the draw-head of the machine which is moved back and forth by a horizontal screw that is rotated in first one direction and then the other, by open and cross belts. The rifling cut is taken on the draw stroke and after the tool has passed through one groove and has returned to the starting point at the breech end of the barrel, the latter is indexed so that the tool on the next stroke passes through another groove. When a cut has been taken through the six grooves, the tool is automatically fed outward a slight amount and another series of cuts is taken through the groove, and so on until all the grooves are machined to the required depth.

The tool is turned as it passes through the barrel, to produce helical or spiral grooves, by the arrangement seen at the left-hand end of the machine. On the spindle which carries

Fig. 6. (A) Drop-forging for Receiver; (B) Finished Receiver

the chuck *C*, there is a gear which meshes with a rack on cross-slide *E*. This cross-slide has a roller on the top which engages with a groove or channel extending along the under side of arm *F*. When the draw-head is traversed along the machine bed by the screw, the cross-slide *E* is caused to move laterally (provided arm *F* is set at an angle with the travel of the draw-head), and this lateral movement turns chuck *C* and the cutter. The amount of this cross movement depends, of course, upon the angular position of arm *F;* graduations on the quadrant *G* show what the position of the arm should be for generating grooves of different leads.

The cutter, which is small and delicate, is relieved on the return stroke to prevent dulling the edge. This is done by a small finger which pushes the cutter back into the head at the end of each stroke. At the opposite end of the stroke a pin in the end of the cutter-head strikes a stop on the feeding head *J* and forces the cutter out (by means of a wedge in the head) to the cutting position. The feeding of the cutter outward at the completion of each revolution of the barrel is effected by a feed-screw at the end of the cutter-head. This screw has a square head, which at the extreme end of each stroke enters a square hole in stop *K*. When the barrel has made one turn, a lug on the indexing disk *L* comes around and through suitable mechanism turns stop *K* slightly. The result is that on the next stroke the feed-screw of the cutter-head, as it enters the square hole, is turned a corresponding amount, the end of the square hole being rounded so that the feed-screw can enter readily. (A sectional view of the cutter-head and a more detailed description of the feeding mechanism was given in the November, 1911, number of MACHINERY.) Lubricant for the cutter is forced through the hollow shank of the tool, connection being made with the draw-head by telescoping pipes which permit the necessary reciprocating movement.

The cartridge chamber in the barrel is reamed to conform to the shape of the "bottle-necked" cartridge used in the 0.22 caliber high-power rifle, and the end of the barrel is finished in the turret lathe by using a combined reamer and face mill. The chamber is then finished by hand reaming to obtain as smooth a surface as possible, because if this chamber

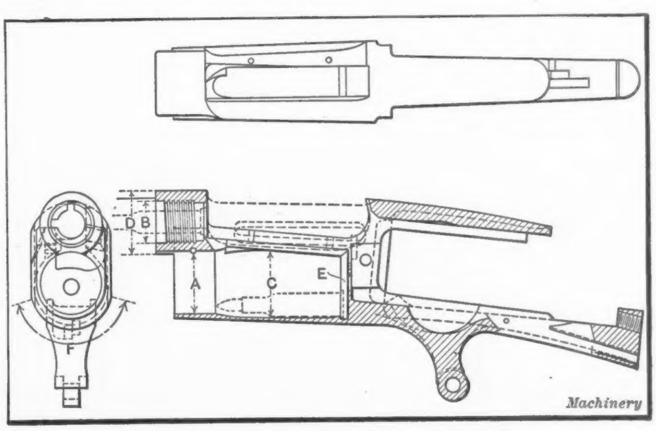

Fig. 7. Plan View and Section of Receiver

were at all rough, the shell when exploded would be forced out into the minute depressions and could not be extracted easily.

Machining the Receiver

The receiver of a rifle is that part between the barrel and breech which contains the "action" or loading and firing mechanism. The receiver of a Savage rifle of the '99 model, which is the style used on the 0.22 caliber high-power type, is illustrated in Fig. 6. The rough drop-forging *A*, from which the receiver is made, weighs 6½ pounds, which is one-quarter pound heavier than the entire weight of the finished rifle, whereas, the finished receiver *B* weighs only one pound thirteen ounces. The total number of operations required on this receiver is 128. A few of the more interesting operations will be referred to in detail.

In order to machine the various interior and exterior surfaces and have them properly located with reference to each other, it is important first to provide surfaces which can be used for locating the receiver in the various jigs and fixtures. The top and left side are machined first on an ordinary Lincoln type milling machine, and practically all subsequent operations are located with reference to these surfaces.

Fig. 8 shows a detail view of a very interesting special machine used for roughing out the magazine chambers A and C (Fig. 7) and the hole B for the barrel, as well as the end surfaces. The magazine chamber is cylindrical at the forward end A, but part C is enlarged and shaped to conform somewhat to the tapering cartridges. This enlarged part is milled out in an ingenious way by the semi-automatic machine shown in Fig. 8. This machine has a spindle for each separate operation to be performed, and the receivers are held in a circular fixture which forms the machine table. The spindles are all fed downward simultaneously by a large cam drum in the center, to which suitable cams are attached. After all the spindles have been fed to depth, the machine is automatically tripped; the spindles are then raised and the work-table is indexed by hand, so that each receiver moves around to the next spindle where the succeeding operation is performed. As all the spindles perform their operations simultaneously, a finished part comes around to the front each time the table is indexed and the operator removes it and inserts a rough forging.

The order of the operations is as follows: First the cartridge chamber hole is drilled with an ordinary twist drill. The bottom of the hole is then squared out by another drill held in the next spindle. The milling of the enlarged part C (Fig. 7) of the chamber then follows. First, a milling cutter enters the hole and for a time simply revolves in a central position while the other tools are at work. When it has reached the proper depth, a gear which is cam-operated and independent of the driving gear turns part of a revolution,

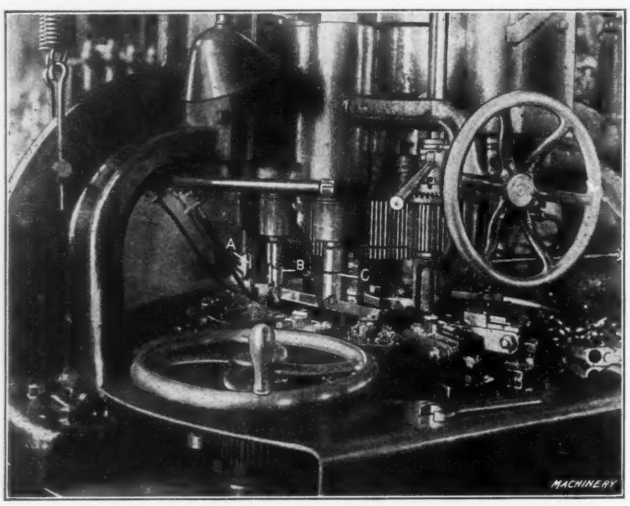

Fig. 8. Special Multiple-spindle Machine for drilling, reaming and milling Rifle Receivers

which locates the spindle and milling cutter in an eccentric position. Then the cutter not only revolves about its own axis but, at the same time, has a circular or planetary motion around the hole, thus enlarging it. When the cutter has finished one revolution, the cam-operated gear again turns slightly in the same direction, thus placing the cutter more off center for taking another cut. At the end of the second cut the gear is automatically returned to the starting point, thus bringing the cutter spindle back to its central position before it is raised for indexing the work-table.

After the chamber is milled as described, the work is indexed to a second milling cutter which operates in the same way and takes a lighter cut around the cartridge chamber. The receiver is now indexed to another drilling spindle where the barrel hole is drilled. This hole is then reamed out by the spindles A and B, Fig. 8, and the top surfaces faced. Finally the outside diameter D (Fig. 7) is machined by the hollow mill C. There are two of these machines, both of which were built by the Adriance Machine Works of Brooklyn.

The surfaces roughed out on the Adriance machine are finished by separate operations on other machines. The cylindrical part A (Fig. 7) and the bottom of the cartridge chamber, as well as hole B and the outside of the circular boss D, are finished in a four-spindle drilling machine equipped with reamers and a hollow mill.

Fig. 9 shows a special fixture used for finishing the enlarged part C (Fig. 7) of a cartridge chamber and for milling a narrow annular recess E at the bottom for receiving the projecting rims of the cartridges. This fixture A is revolved by worm gearing B and the receiver R feeds around the rotating cutter, which removes just enough stock to finish the cartridge chamber.

Another revolving fixture used for milling the outside surface F (Fig. 7) on the bottom of the receiver is shown in Fig. 10. The fixture in which the work is held is also revolved by

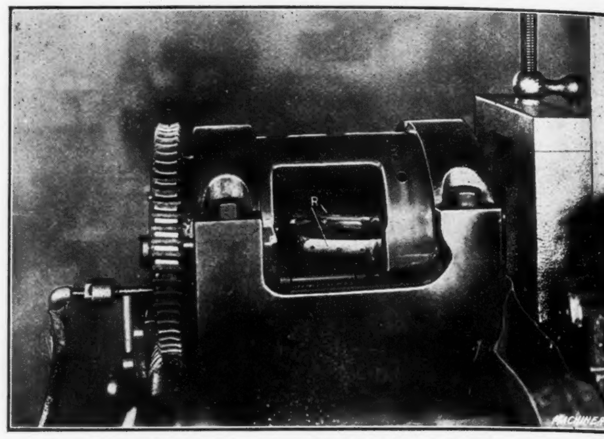

Fig. 9. Special Attachment on Lincoln Milling Machines used for finishing Cartridge Chamber of Receiver

worm gearing. The receiver R is located by the top and side locating surfaces and it is held by a clamp across the tang and plugs which enter the barrel and chamber holes. The milling cutter C, which is supported at the outer end by a bracket A, simply revolves in a fixed position and the work feeds around it. When the cut is completed, the rotation of the fixture is stopped automatically by the disengagement of the driving worm.

Fig. 11 illustrates how the thread for the rifle barrel is cut in the receiver. This thread is milled by cutter A and the receiver R is held on a rotating fixture B. The spindle of this fixture passes through a bronze nut in the main bearing of the machine, and when milling the thread the revolving spindle and fixture feed forward at a rate proportional to the pitch of the thread. The spindle is rotated through worm and spur gearing. When the thread is completed, the forward feeding movement of the fixture is automatically stopped by a trip which releases a catch and allows the feed-worm to be quickly drawn out of mesh by a spring. The continuous thread which is milled with this machine is partly cut away at the top and bottom of the threaded hole so that the barrel, the thread of which is also milled and then cut away to match the receiver, can be removed by simply turning it one-fourth of a revolution. When the barrel has been

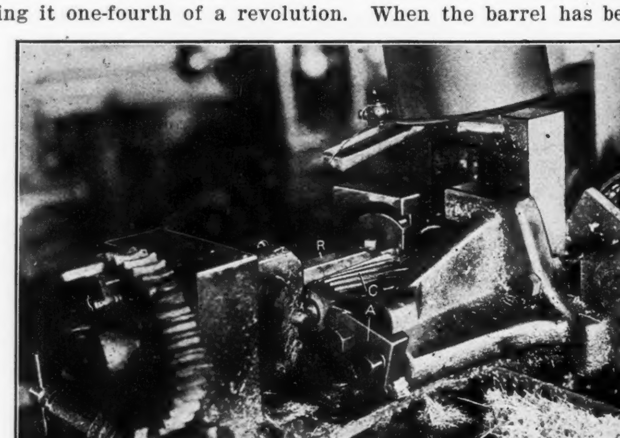

Fig. 10. Rotating Fixture used for milling Round Bottoms of Receivers

turned this amount, the threads on it are aligned with the unthreaded part of the receiver. The threads in the latter are cut away in a profiling machine.

Stock Turning Machine—Wood Profiler

A detail view of one of the lathes used for turning the rifle stocks is illustrated in Fig. 12. This lathe is similar to

the type used for turning shoe lasts and other irregular shapes. There is a former *A* which corresponds to the shape of the finished stock. This former is mounted on one side of an oscillating frame *B* which carries on the opposite side the walnut stock *C* that is to be turned. The former and stock are rotated simultaneously by gears connecting shafts *D* and *E*. The cutter-head *H*, which is equipped with six U-shaped cutters, is mounted on a carriage *F* and traverses along the bed as the stock is turned. The wheel *G*, which bears against the former, also moves along with the carriage.

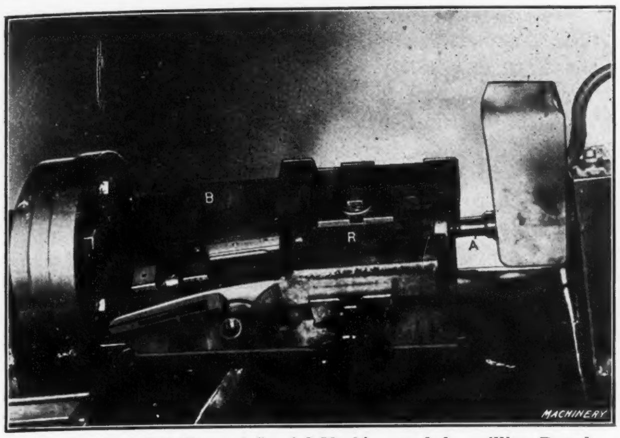

Fig. 11. Detailed View of Special Machine used for milling Barrel Thread in End of Receiver

The contact of the former with this wheel causes frame *B* and its shafts *D* and *E* to oscillate in such a way that the stock is turned to the same shape as the former. The cutter-head rotates very rapidly and when the cut is completed the carriage feed stops automatically.

The walnut which is used for rifle stocks must be carefully seasoned and dried before it is suitable for use. There are four classes of stocks, *viz.*, the plain walnut, the semi-fancy, the fancy, and the circassian. The "fancy" stocks are so classified because of the beauty of the grain and are used for the more expensive rifles.

The forward ends of the stocks are cut out to fit the upper and lower receiver tangs in a machine similar to that shown in Fig. 13, which operates on the same principle as a metal profiling machine. The cutters revolve very rapidly and are guided by a former plate as at *A*, which is engaged by a guide-pin, thus controlling the movement of the cutter. This machine has four spindles into which cutters of different shapes and sizes can be inserted. In this case only three of the four spindles are being used. The vertical position of each cutter is regulated by the adjustable stop-screws seen at the right of each spindle slide. Such accurate work is done by this machine that practically all band fitting is eliminated. The stocks are next finished smooth by the use of garnet

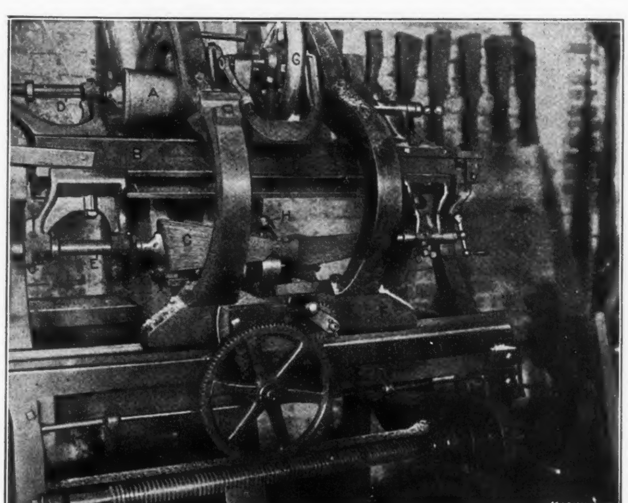

Fig. 12. Machine used for turning Walnut Rifle Stocks

paper and then they are ready for finishing. The grain of the wood is filled to secure a smooth surface and after the application of shellac and varnish, the stocks are given a polish by rubbing with a mixture of pumice stone and paraffine.

Checking and Ornamental Engraving

The checking on the stocks as well as the carving on the fancy stocks is done entirely by hand and, obviously, requires a great deal of skill and artistic ability. The engraving on the sides of the receiver, etc., is also done by hand. In many cases special designs have to be engraved to order. A drawing of the design is first made on paper. When this has been approved, another drawing is made directly on the polished steel surfaces to be engraved. A very light coating of grease is first applied to the polished surface, and part of the design, in case there is considerable detail and the design is large, is then drawn with a sharp-pointed lead pencil; these lines are then traced with a sharp steel pencil. The engraver now has a light outline to serve as a guide and the design is then cut out by small hand tools. This work must be done by the aid of a magnifying glass, and great care is required to prevent the tool from slipping and cutting farther than was intended or in the wrong direction. An example of artistic carving and engraving is shown in Fig. 1. To engrave a fancy design such as this one requires considerable time and a degree of skill which few men possess.

In a succeeding article some interesting profiling operations on rifle and automatic pistol parts will be described.

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Some years ago, it was shown by a series of experiments conducted by A. E. Outerbridge (*Journal of the Franklin Institute*, February and April, 1904) that cast iron subjected to alternate heating and cooling increased in dimensions with-

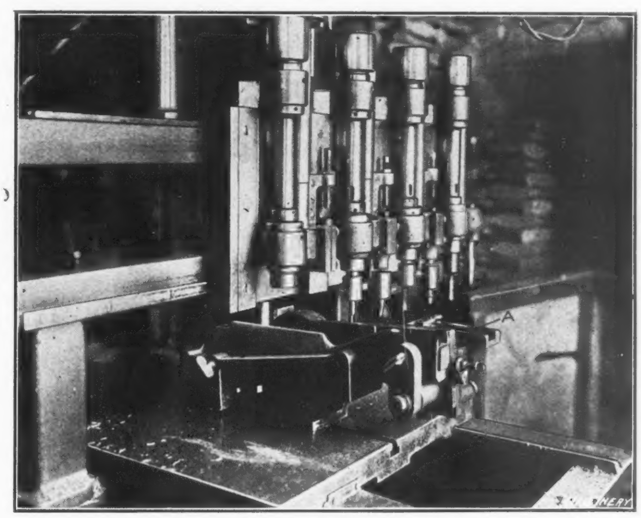

Fig. 13. Profiling Machine for cutting out Forward End of Stock to fit Receiver Tangs

out increasing in weight, whereas wrought iron under the same treatment contracted slightly in all dimensions. The cast-iron test bars used in these experiments increased in dimensions from 14 13/16 by 1 inch by 1 inch to 16 1/2 inches by 1 1/8 inch by 1 1/8 inch. The wrought iron bars decreased 1/8 inch per foot in dimensions and the cast-iron bars increased in volume about 40 per cent. The opinion was expressed in connection with these experiments that the strength of cast iron decreases in proportion to the increase in volume. These facts indicate that cast iron is not the best material to use where castings have to be subjected to comparatively high temperatures. Wrought iron castings now available have been demonstrated by comparative tests and observations to be far superior, outlasting ordinary cast iron from four to six times.

* * *

A German chemical publication states that coatings composed of rubber mixtures, raw or semi-vulcanized, prepared from low-grade rubbers rich in resin, and preferably containing large proportions of factis (a rubber substitute) and inorganic fillers, when pierced by a projectile, will close over the hole and so prevent the inrush of water. The coating may be made more resistant to water by adding tar. It is laid on or cemented to the hull of a ship and painted to protect it from attack by marine life.

METHODS OF HOLDING AND MACHINING THIN WORK*

SHOWING WAYS OF SUPPORTING SLENDER PARTS AND EQUALIZING THRUST OF CUTS TO AVOID DISTORTION

BY ALBERT A. DOWD†

IN nearly every kind of manufacturing it becomes necessary to machine certain pieces of work which are of a fragile nature, and which can neither be held nor machined by ordinary methods without considerable distortion. Sometimes the work is a casting of very thin section, while in other instances a forging is to be cut down until the walls are not over 1/8 inch in thickness. The work may be of comparatively small diameter or it may of large size, and it may also be either long or short. It may be cylindrical in form or of irregular shape, and may occasionally require the addition of holding lugs in order to hold it properly. In the machining of this class of work we shall consider two types of machines only—the horizontal and the vertical turret lathes. The horizontal type of machine would naturally be used for the smaller work, while the larger pieces can be more profitably handled on the vertical machine. While work of this character must be very carefully held in order to avoid distortion, the problem of machining is also of great importance. It is quite possible to hold a piece of work so that it will not spring out of shape, and yet the machining operations may be very unsatisfactory due to vibration in the work itself. This causes chatter which nearly always ruins both the work and the tools used in machining. Vibration is more apt to be troublesome on long work than on the shorter pieces, because the torsion or twisting action induced by the pressure of the tools in removing stock is more apparent when this action takes place at a considerable distance from the points at which the work is supported and held. On short work the support is nearer the point at which the work is being done, and there is consequently less chance for the metal to twist under the pressure of the cut.

In connection with the machining it is well to note that the speed and feed have a great influence on the vibration, but it is difficult to give a definite rule which will apply to all conditions. Methods of holding have a great influence on this matter, for it is obvious that the more securely the work is held, the greater may be the feed and speed, other things being equal. Speaking generally, less vibration results when slow speeds are used with fairly coarse feeds, but this is not always the case. Sometimes it is possible to run the work at a fairly good speed using a fine feed, while at other times a procedure of this kind will cause chatter which can be heard all over the factory. An increase of one step in the feed or a decrease of one step in the speed will frequently stop the trouble, but there are occasional instances which require considerable experimenting before the desired result is obtained. When outside and inside cutting are going on at the same time, it is a good plan to arrange the boring and turning tools so that they are working opposite each other; that is, the tools should be working one against the other with nothing but the wall of the casting between them. If used in this way there is less chance of springing the work, and also less chance of vibration. In handling thin work, special care must be taken to see that all bearings, gibs, etc., are set up snugly, so that no chatter will be caused in the machine itself. The tool-holders and the tools themselves must also be as solid as possible. A few points in connection with the handling of work of this character may be of interest and are given herewith.

Important Points relating to the Handling of Thin Work

1. The method of holding should be very carefully thought out with a view to rigidity and freedom from distortion of the work itself. It may be advisable in some cases to have supplementary lugs or pads added to the pattern in order to facilitate chucking. When this is necessary it is well to consult with the pattern-maker, so that unnecessary expense in the pattern will be avoided.

* For articles on work holding devices and kindred subjects, see "External Holding Devices for Second-operation Work," in MACHINERY, June, 1914.
† Address: 84 Washington Terrace, Bridgeport, Conn.

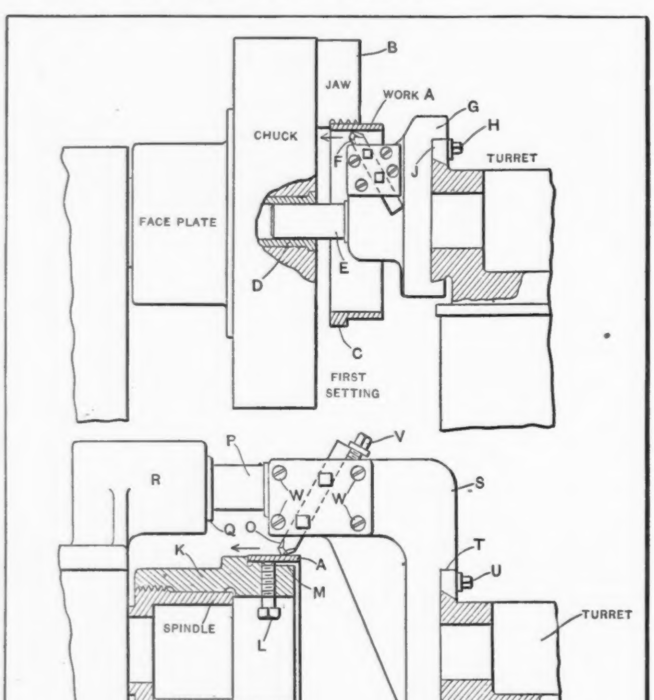

Fig. 1. Machining a Thin Steel Casting on a Horizontal Turret Lathe

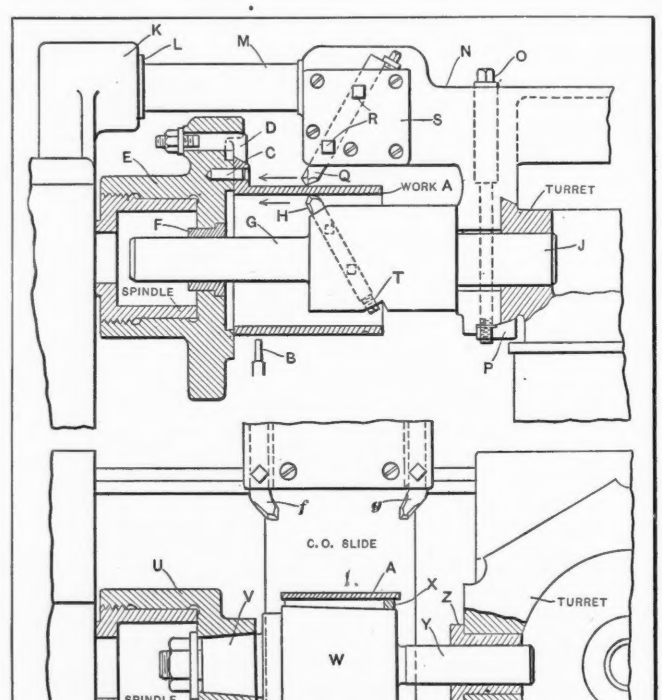

Fig. 2. Machining a Sliding Sleeve in a Turret Lathe

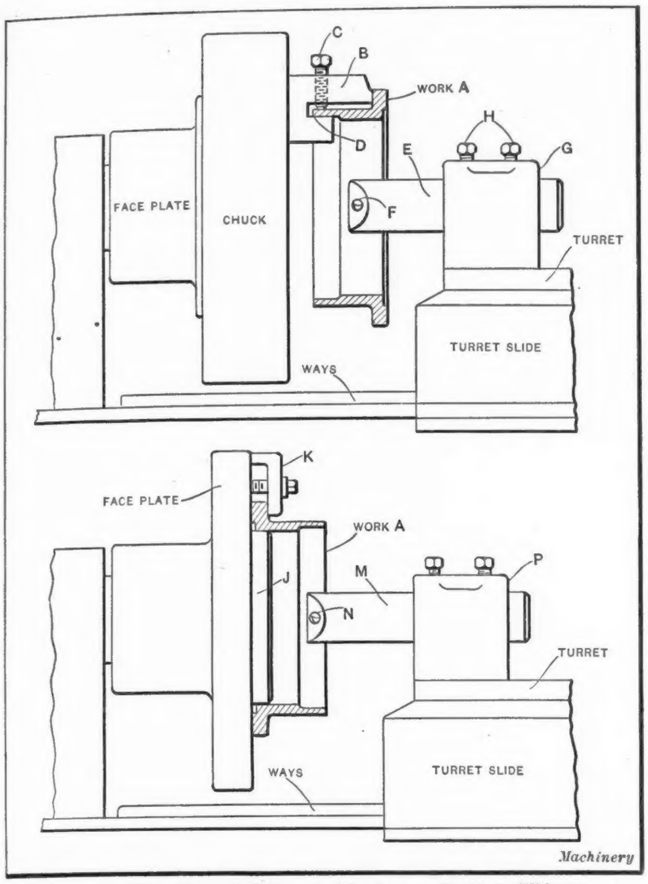

Fig. 3. Thin Flanged Collar machined on a Pratt & Whitney Turntable Lathe

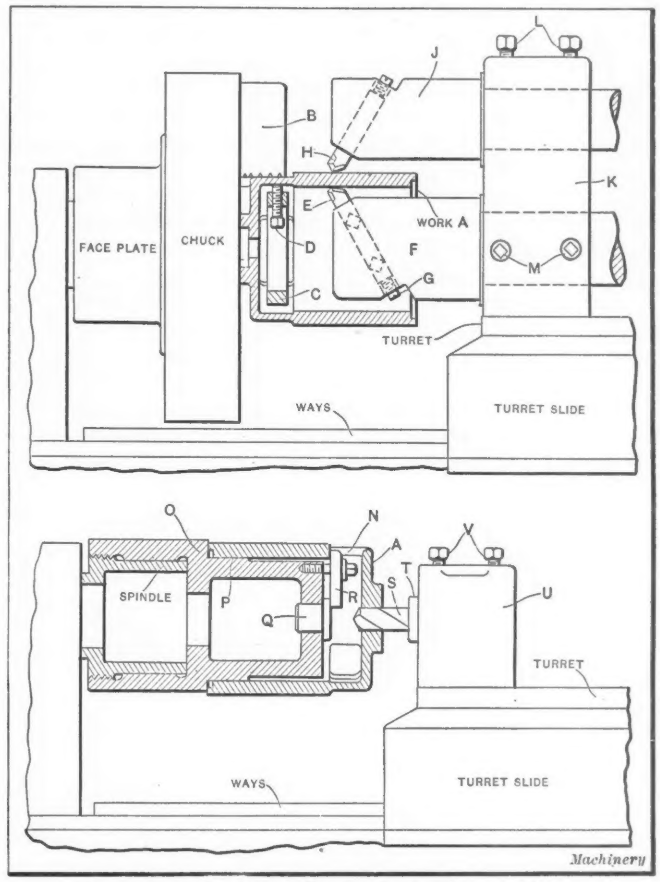

Fig. 4. Steel Casting of Fragile Construction machined on Turntable Lathe

2. The overhang from the spindle should be as short as possible, so that vibration will not be caused by an excessive weight revolving without support at its outer end.

3. The rapidity of operation is an important point if a great many pieces are to be machined. Clamps should be easily accessible and conveniently operated. It is advisable to make all nuts of the same size so that one wrench can be used for all. It is also desirable to make them of such a size that a standard machine wrench can be used.

4. The locating surfaces, if the work is irregular, should be carefully selected, so that inequalities of the casting will be equalized as far as possible. Care should be taken so that no locating points come where the casting is gated or where letters or numbers appear. Neither should they come where the pattern is parted.

5. The tooling should be very carefully studied both from the viewpoint of upkeep and of rigidity, so that every possible precaution may be taken to prevent chatter.

6. The cost of equipment should be considered on the basis of the number of pieces to be machined. Obviously, it does not pay to design very elaborate equipment for work which will not be machined in large quantities.

7. The selection of a machine best adapted to the work is an important point, and should be decided upon before anything is done in the line of equipment.

Machining a Thin Steel Casting on a Horizontal Turret Lathe

The work shown at *A* in Fig. 1 is a steel collar which is to be finished all over on a horizontal turret lathe. When in the rough, the thickness of the wall of the casting is 5/16 inch, and it is to be finished to 3/16 inch. As the work is so thin that the action of the chuck jaws would tend to crush it out of shape, if they were used in the ordinary manner, the driving lug *C* was added to the casting. In this way much less pressure is required on the jaws than would be the case if friction only were used for driving. It will be noted that the jaws *B* have a narrow shoulder against which the work rests. The body *G* of the boring tool is of cast iron and is fastened to the turret by the angular gib *J* and the screws *H*. A pilot *E* of tool steel is hardened and ground to fit the bushing *D*, which is forced into the chuck body. The tool *F* is set in a vertical plane in the holder in order to minimize errors in indexing the turret. Two holders of this kind are used for the work, and the cut-off slide tools face the end of the collar. While the piece is being rough-bored, the jaws are set up firmly on the work, but care is used so that too much pressure is not applied. Before the finish-boring takes place the jaws are loosened up to take care of the spring of the casting.

In the second setting (shown in the lower part of the illustration), the work *A* is pushed onto the arbor *K* which is screwed onto the end of the spindle; the cup-pointed driving screw *L* is set up against the finished inside surface. A shallow groove *M* is provided so that the burr thrown up by this screw will not cause trouble when removing the work. A moment's work with a scraper takes out the slight roughness after the work has been removed from the arbor. The grooves *N* on the periphery of the arbor facilitate the removal when the casting has been machined. The body of the turning tool *S* is fastened to the turret by gib *T* and screws *U*, and it has a pilot of steel at its forward end *P*. This pilot enters a bushing *Q* in the spindle cap bracket *R*, thus greatly assisting in the prevention of chatter. A steel plate is fastened to the body by four screws *W*, and supports cutting tool *O*. A refinement will be noted in the backing-up screw *V* which permits fine adjustments to be made. It was found advisable to cut off the lug *C* with a hacksaw previous to this setting, as the interrupted cut produced when attempting to machine it off with the turning tool tended to twist the work on the arbor.

Machining a Sliding Sleeve

The sliding sleeve shown at *A* in Fig. 2 is of cast iron, 1/8 inch thick when finished. Its outside diameter is important and its overall length also. It is likewise essential that the two ends should be parallel, and square with the outside. The casting is made up in the form of a pot with three beveled lugs spaced 120 degrees apart. The end of the pot is rough-ground on a surface grinder, and three holes *C* are jig-drilled to act as drivers and locaters. This work was done previous to the machining of the piece on the turret lathe. The fixture body *E* is then screwed to the spindle of the machine and is furnished with driving and locating pins which enter the drilled holes. The hook-bolts *D* are beveled

to the same angle as the lugs and extend back through the body so that they may be tightened from the rear, thus leaving the front of the fixture free from projections and permitting the turning tool to work without interference. Attention is called to the manner in which the hook-bolts are backed up by the boss, which is cut away at one side so that the bolt can be turned out of the way when assembling or disassembling the work. The body of the fixture is provided with a bushing *F* which acts as a guide for the pilot of the boring-bar *G*. This bar is firmly secured in the turret at *J*, the regular turret binder being used to hold it. The tool *H* is adjustable for diameters through the backing-up screw *T*. The outside turning is accomplished by means of double-end turning tool *N* which is fastened to the turret faces by the gibs *P* on the lower dovetailed faces, these being secured by the long special screws *O* which pass down through the body of the tool. A steel pilot *M* enters the bushing *L* in the spindle cap bracket *K*. A steel plate *S* is mounted on the body, and tool *Q* is secured in place by two screws *R* which pass through the plate. A collar-head screw is provided by means of which fine adjustments can be readily made. Attention is called to the manner in which the turning and boring tools are arranged so that they are working opposite each other, thus tending to keep the work nearer to size than would be the case if they were set to cut on different portions of the casting. After the work has been finished, the parting tool *B* cuts off the end of the sleeve slightly longer than required, so that a finish allowance is made for the second setting.

The second setting is shown in the lower part of the illustration and consists of roughing and finish-facing both ends of the sleeve to the prescribed size. For this setting the work *A* is held on the arbor *W*, the expanding sleeve *X* being forced up on the taper in the usual manner. A nose-piece *U* is screwed to the spindle and receives the tapered end of arbor *V*, while the other end *Y* is hardened and ground to a

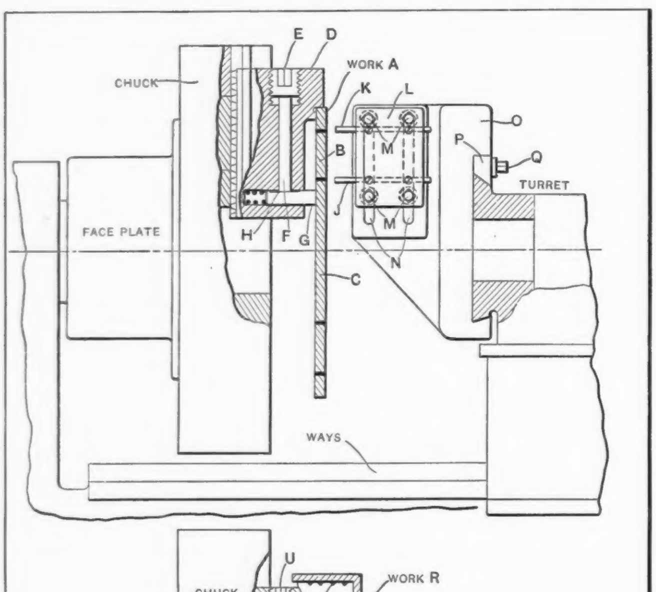

Fig. 5. Cutting out a Thin Sheet Steel Collar and turning, boring and facing a Thin Steel Drum

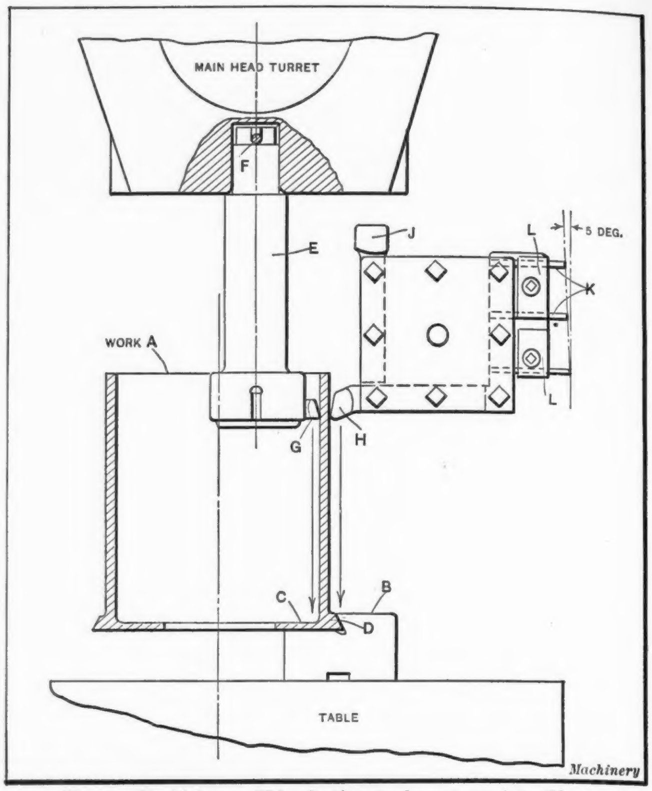

Fig. 6. Machining a Thin Casting to be cut up into Rings on the Vertical Turret Lathe

nice running fit in bushing *Z*, located in the turret. A special tool-block *a* is mounted on the front of the cut-off slide and holds the two rough-facing tools *b* and *c*. The tools enter slots in the block and are held in place by the set-screws shown. A ledge is cast at *d* on the rear of the block to allow the use of adjusting screws *e*. The finishing tools *f* and *g* are mounted in a special block on the rear of the cut-off slide in the same manner as those in front.

Machining a Thin Flanged Collar on the Turntable Lathe

A turntable lathe made by the Pratt & Whitney Co. is used to machine the collar shown in Fig. 3, the cross-sliding turret of this machine being used to perform the facing operation on the flange and the cutting of the recess. The work *A* is held in the special jaws *B* of the three-jawed chuck, that portion of the jaw marked *D* being brought up lightly against the inside of the thin end of the work and the set-screw *C* tightened. The forward end of the jaw is used as a support for the flange and also serves to locate the work longitudinally. The boring-bar *E* holds the tool *F* which does the boring, the turret being set off center a sufficient amount to bore the required diameter. The tool-holder *G* is one of the regular type commonly purchased with the machine. The two set-screws *H* are used to force down a beveled shoe which, in turn, serves to contract a split bushing which grips the bar. In connection with this equipment attention is called to the fact that the jaws are used principally for centering the work, being brought up very lightly on the inside of the work so that they have no tendency to distort the casting. The set-screws are then set up tightly on the outside, and as the piece is backed up by the jaws on the inside, there is no danger of springing. A metal-to-metal contact is obtained in this way and any tendency toward vibration is avoided.

The second setting of the work is shown in the lower part of the illustration. For this setting a faceplate is used with a locating plug *J* which fits the previously bored interior, the flange face being brought up against the finished face of the plate. Three clamps *K* secure the work. The boring-bar *M* holds tool *N* for boring the thin portion of the work, the turret being set off center for this purpose as in the first setting. The bar is held in the same type of holder *P* as that shown above.

Machining a Steel Motor Casting

The work shown at *A* in Fig. 4 is a steel motor casting of somewhat fragile construction at its inner end. This is

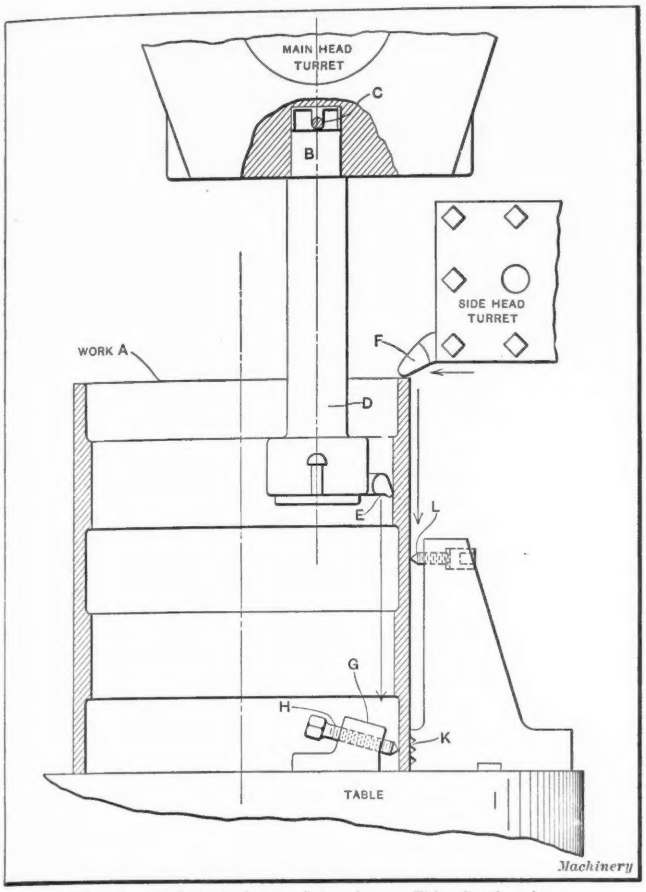

Fig. 7. Boring, facing and turning a Thin Casting in a Vertical Turret Lathe

another instance in which the turntable lathe is used. It will be noted that the casting is cored out at its inner end, so that there are three elongated openings at this point. In order to clamp the work without distortion, a steel ring *C* is provided with three set-screws *D*. This ring is placed in position in the casting before it is gripped by the jaws, the set-screws being set up with a moderate pressure against the inside of the walls. The casting is then placed in the chuck in such a way that these set-screws come opposite to the jaws. The jaws *B* may now be set up firmly without danger of crushing the work, the pressure being taken by the screws. The double tool-holder *K* is fastened to the turret face, and the set-screws *L* and *M* clamp the bars in position. These bars extend across the turret and the other ends are used for the finishing tools. The turning bar *J* is provided with a tool *H* which goes through the bar at an angle so that the tool is slightly in advance of the bar, thus permitting work to be done close up to a shoulder. A backing-up screw is provided for fine adjustments. The boring-bar *F* is arranged in the same manner, tool *E* being backed up by screw *G*.

The second setting is shown in the lower part of the same figure, the work *A* being held on a special arbor *O* which is screwed onto the end of the spindle. The finished end of the work is brought up against the shoulder on the arbor, the work being held on the portion *P* which fits the inside of the casting. The clamps *R* enter the cored holes in the casting *N*, and the steel stud *Q* forms a support for their inner ends. The tool-holder *U* is of the same type as previously described, the bushing *T* being compressed by two screws *V*, so that it holds the drill *S*. Other tools used in this setting are of a simple nature and need not be described. The facing is obviously done by the transverse movement of the turret.

Cutting Out a Thin Sheet Steel Collar

The illustration in the upper part of Fig. 5 shows a piece of hexagonal plate at *A* from which the thrust washer *B* is to be cut. In this work the center part of the blank *C* is saved and used for other work, but the outside portion is scrapped. The outside of the blank is held in the special jaws *D*, each of which is provided with a spring plunger *G*, a binding plug *F* and a hollow set-screw *E*. One side of the plunger is flatted off with a slight back taper as shown at *H*, so that any tendency to push back is offset by the wedging action of this taper. In operation, the plungers are first pushed down out of the way, and the jaws tightened, after which the plungers are released until they come in contact with the plate. The screws are now tightened and the work is ready for machining. A special tool-holder *O* is secured to the turret by angular gib *P* and screws *Q*. A steel tool-block *L* is mounted on a finished pad and is held in any desired position by the four screws *M*, which pass through the block and the body of the holder and are secured on the other side by nuts and washers. Vertical movement of the block is permitted by the elongated slots *N*, thereby allowing a number of different diameters of washers to be cut with the same tools. The tools *J* and *K* are ground on the sides to fit the slots in the block, and it should be noted that the lower of the tools is set forward slightly in advance of the other so that the center piece *C* will be cut out before the separation of the outer ring occurs.

Turning, Boring and Facing a Thin Steel Drum

The lower illustration in Fig. 5 shows another piece of work in which the same type of jaw with spring plungers is used to support the casting. In this case the jaws are so made that they grip the inside of the shell at *S*, while the plungers *T* come up against the web and assist in supporting it against the pressure of the cut. The same construction is used in the binding plug *V* and the hollow set-screw *U* as in the upper illustration. The facing of the web is performed by the cut-off slide tools while the boring-bar *Z* is cutting out the central portion with the tool *Y*. The forward end of this bar is hardened and ground at *X* to a running fit in the chuck bushing *W*. This piece of work was completed in another setting by holding it in soft jaws which extended in to form a support for the web.

Machining a Thin Ring Pot on the Vertical Turret Lathe

We now come to work of a larger size which can be handled to good advantage on the vertical turret lathe. On this type of machine the work stands vertically, so that there is no overhang of the spindle to contend with as on the horizontal type of machine. Aside from this, the conditions are similar

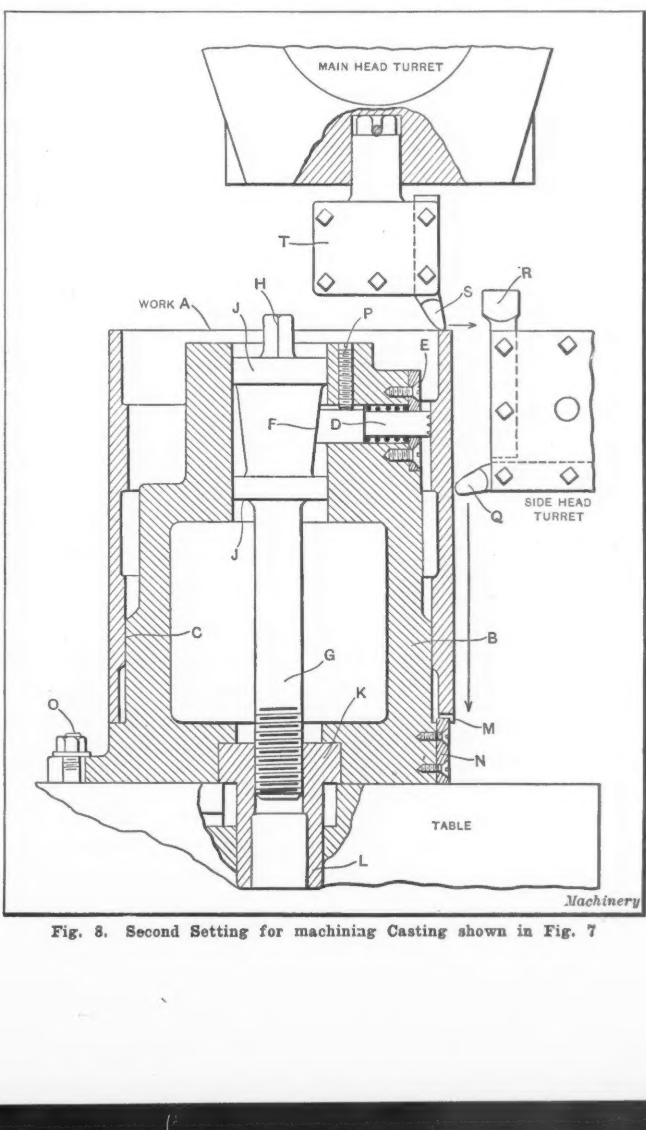

Fig. 8. Second Setting for machining Casting shown in Fig. 7

in both types. As the tools hang vertically, excessive overhang from the turret is not so apt to produce chatter as in the horizontal type of machine.

Fig. 6 shows a cast-iron ring pot from which four thin rings are to be machined. The pot casting *A* has a beveled flange around its lower end and is reinforced on the inside by web *C*. The jaws *B* are beveled to the same angle as the flange at *D* and, therefore, have a tendency to draw the

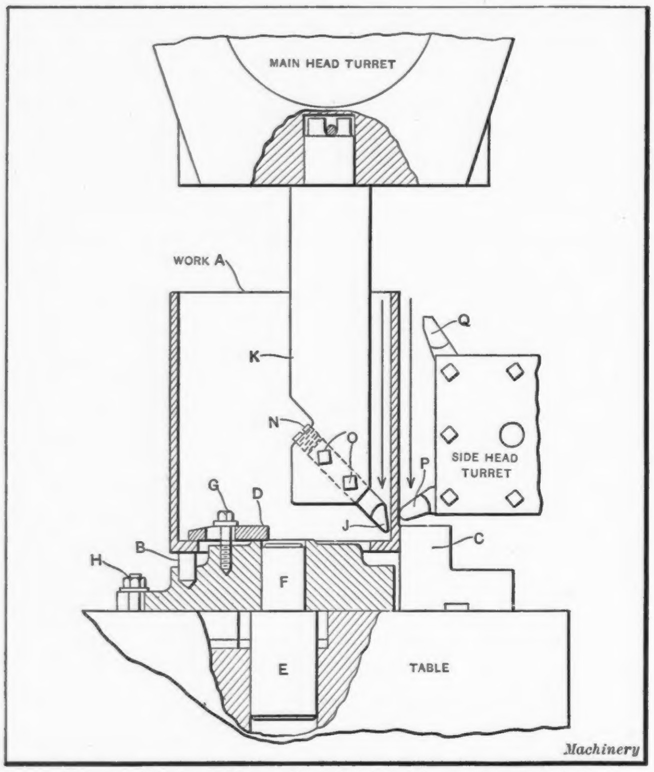

Fig. 9. A Thin Cast-iron Shell finished all over in a Vertical Turret Lathe

work down as well as to center it. The inner web tends to prevent crushing the pot when pressure is applied to the jaws. The bar *E* is a combination boring and reaming bar (as manufactured by the Bullard Machine Tool Co.), and is provided with slip-cutters and floating reaming cutters. (This type of bar was fully described in an article entitled "Design and Construction of Boring Tools," MACHINERY, March, 1914.) In this particular case the reaming cutters are not used, but roughing and finishing tools as shown at *G* are used in boring the casting. The shank of the bar fits the turret hole and is prevented from turning by pin *F*. The side-head turret holds roughing tool *H* and finishing tool *J*, these tools being used to turn the exterior of the pot. It should be noted that the boring and turning tools are working opposite each other, in the manner previously described. A special supplementary tool-block is fastened to the opposite side of the side-head turret and carries the three tools *K* which cut off the rings. These tools are ground on the sides so that they fit the slots in the tool-block, and are held in place by straps tightened by screws *L*. Attention is called to the fact that these tools are set so that a line passing through their cutting edges forms an angle of 5 degrees with the perpendicular. This is done so that the rings will be cut clean without ragged and broken edges, as only one ring is cut off at a time.

Machining a Piece of Electrical Work

The work *A* shown in Fig. 7 is a steel casting which is to be bored on the two internal annular pads, faced on the two ends, and turned on the outside. The casting is centered by the lower part of the special jaws *K*, these being brought up lightly against the casting so that they do not distort it. The screw dogs *G* on the inside of the work are then tightened until the pointed screws sink into the casting, thus holding the lower end firmly. The pointed set-screws *L* in the upper part of the jaws are now brought up against the work and tightened, after which the piece is ready for the machining operations. For boring the inside pads a special bar of the same type as that shown in Fig. 6 is used, the bar *D* being extra long. The shank *B* fits the turret and is driven by the pin *C*. A roughing and finishing slip-cutter *E* does the boring, while tool *F* in the side-head turret faces the end and turns part of the periphery.

The second setting is shown in Fig. 8, but between the first and second turret lathe operations a slot *M* is milled across the lower end of the casting to assist in driving. The work is held during the second setting on the special locating fixture *B*, which is made of cast iron and bolted to the table by the three bolts *O*, tee-shaped at their lower ends and fitting slots in the table. The centering plug *K* is a drive fit in the fixture body and is turned down at *L* to fit the center hole in the table. A steel strip *N* is fastened to one side of the body and its upper end acts as a driver in the slot *M*. The lower part of the outside of the body is turned at *C* to a nice fit in the casting.

The upper portion is firmly held by three expanding pins *D* which are flatted on one side where the screws *P* bear against them to prevent turning. The pins are shouldered for the coil springs and are beveled at their inner ends to fit the angle *F* on the operating rod. Three steel plates *E* are let into the casting to act as cover plates and hold the springs in place. The operating rod *G* is of tool steel with its lower end threaded with an Acme thread in bushing *K*. Two narrow rings on the upper end *J* are made cylindrical and a square portion is milled to receive a wrench by means of which the mechanism is operated. It will be seen that the purpose of the pins is to steady the upper portion of the casting and prevent torsion which might result under the pressure of the cut. Excessive pressure is not necessary on these pins, as a great amount of the driving is done by the block *N* at the lower end. The tool *S* is used for facing the

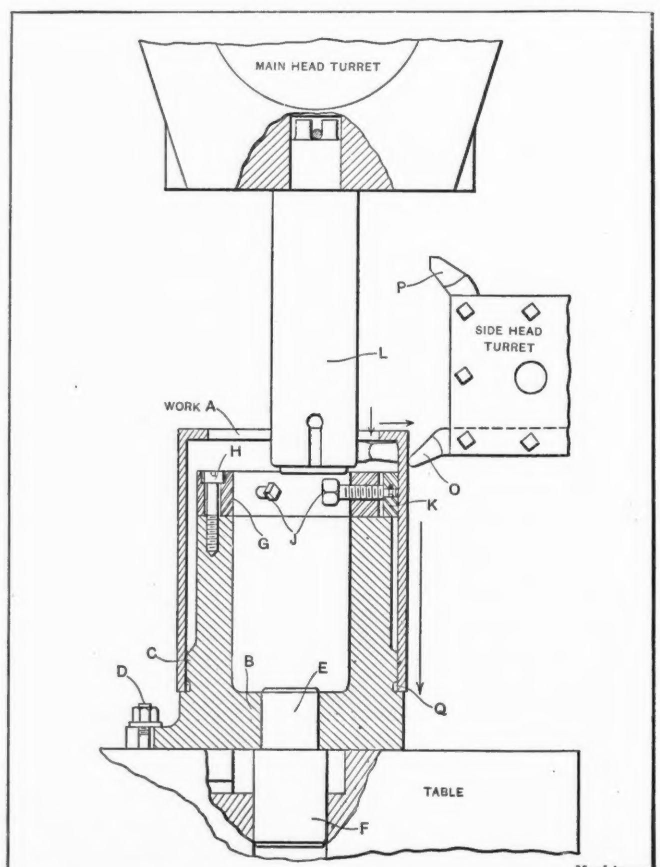

Fig. 10. Illustration showing Second Setting of Same Casting as shown in Fig. 9

end of the casting and is held in one of the regular toolholders *T*, the shank of which fits the turret hole and is driven by a pin. The side-head holds two tools *Q* and *R* which are used for roughing and finishing the periphery.

Machining a Thin Cast-iron Shell

The work shown at *A* in Fig. 9 is of cast iron and is finished all over, the side walls being only 3/16 inch thick when finished. A cast-iron base is held down on the table of the

machine by the three bolts *H*, which are tee-shaped at their lower ends and fit the table T-slots. A steel plug is forced into the base at *F* and fits the center hole in the table at *E*, thereby locating it centrally. Three hardened steel pins *B* are inserted in the base and act as supporting points for the casting. The three clamps *D* are operated by screws *G* and are slotted so that they can be pulled back, out of the way, when inserting or removing the work. In setting up, the jaws *C* are used to center the work, but they are not set up very tightly for fear of buckling the casting. Two special bars *K* are used for the roughing and finishing boring; tools

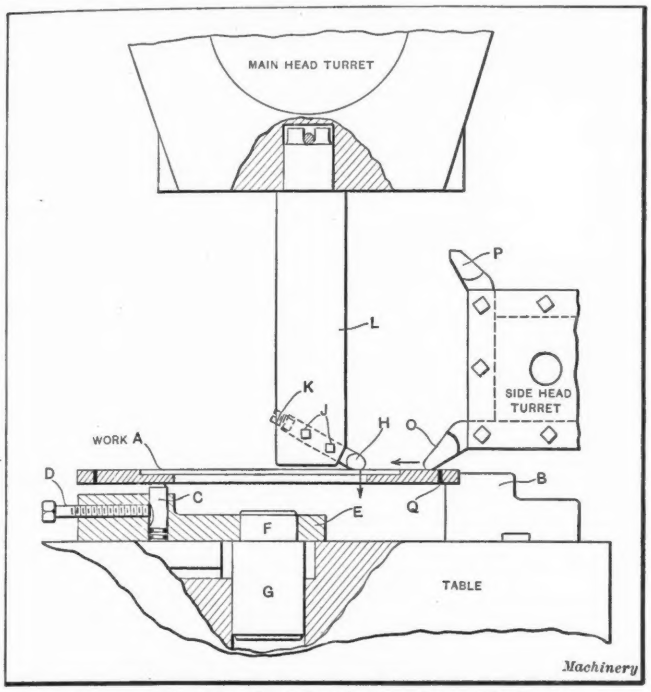

Fig. 11. Machining Steel Sprocket for Automobile Trucks

J are put in at an angle of 45 degrees so that there will be no interference with the clamps when near the bottom of the pot. Two screws *O* clamp the tools in place, and a backing-up screw *N* permits fine adjustments to be made. The tools *P* and *Q* in the side-head are used for roughing and finishing, and when in use are kept directly opposite the boring tools.

The second setting of the same casting is shown in Fig. 10, this operation consisting of boring the hole through the flange and undercutting it, and also approximately matching up the unfinished portion of the inside with that previously machined. The fixture body *B* is made of cast iron and is bolted to the table in the usual manner by the three bolts *D*. A locating stud *E* is forced into the body and fits the center hole in the table at *F*. The lower part of the body is turned at *C* to fit the inside of the bored shell. A shoulder is provided against which the finished end of the work is located, and a groove *Q* is cut so that trouble will not be caused by chips and dirt. A steel ring *G* is fastened to the upper end of the body by three screws *H* in such a way that there is clearance around the body of the screw; thus a floating or equalizing action is permitted. Three steel shoes *K* are let into slots in the ring and are controlled by screws *J* which pass through the ring. It will be seen that this arrangement permits the screws to be tightened sufficiently to perform their function without fear of forcing the work out of true, due to an unequal pressure on the screws, as the floating ring equalizes the strain. The boring-bar *L* used for the work is of the same general type as previously described, slip-cutters being provided for both boring and undercutting the flange. The facing of the flange is accomplished by tools carried in a regular tool-holder as shown in Fig. 8, while the outside turning is done by the roughing and finishing tools *O* and *P* in the side-head turret.

Machining a Steel Sprocket

The work shown in Fig. 11 is rather out of the ordinary. The piece when completed is a steel sprocket, such as used on automobile trucks. Two settings are required to complete the work, but the first one of these is the only one in which we are interested. The pieces from which the sprockets are machined are octagonal in shape and are of rolled steel with a large hole punched in the center. The work is roughly centered and gripped by the outside in the special jaws *B*. A cast-iron spider casting *E* is centered on the table by stud *G*, which fits the center hole in the table and the upper end *F* of which is a drive fit in the spider body. Three spring plungers *C* support the inner part of the plate and are locked in their positions by set-screws *D*. In operation, these plungers are pushed down, out of the way, until the jaws have been tightened, after which they are released and the set-screws tightened. The tooling for this piece of work is not out of the ordinary, bar *L* being similar to the one shown in Fig. 9, except that tool *H* is put in at an angle of 30 degrees instead of 45. The screws *J* hold the tool, and the backing-up screw *K* permits of fine adjustments. The tools *O* and *P* in the side-head are used for roughing and finish-facing. The recess is cut by a tool in the main head, while the final operation of cutting out the work at *Q* is accomplished by a parting tool in the main head.

Machining a Large Pot Casting

The work shown at *A* in Fig. 12 is of cast iron and is machined completely on the inside while the outside is turned as far as the finished pad extends. The work is held by the outside in the standard jaws *B*, supporting the bottom of the pot on the raising buttons *C*. A lug *D* on the outside of the pot acts as a driver against the side of the jaw. A long special tool-holder *J* holds the two tools *E* and *F*, these being held in place by set-screws *K*. These two tools turn the hub and bore the inside of the pot. At the same time that this

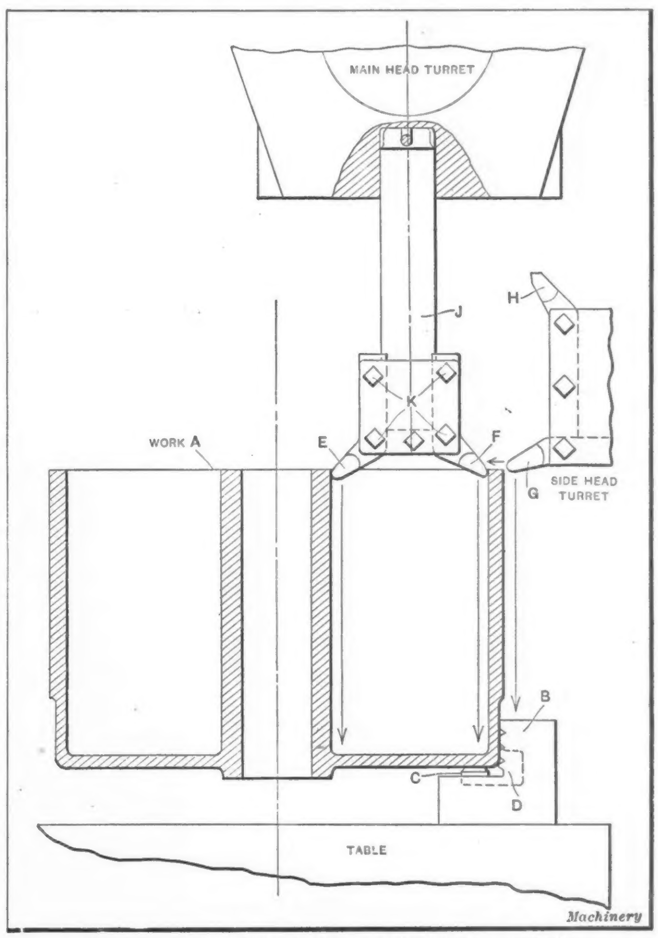

Fig. 12. Another Thin Casting machined in the Vertical Turret Lathe

operation takes place on the inside, tool *G* in the side-head turret is turning the outside diameter. The cutting points of all three tools are in a line. Another long tool-holder holds the tools for the inside finishing while tool *H* in the side-head completes the outside work.

* * *

The use of boron in aluminum-bronze makes an alloy which will not tarnish as readily as a bronze that does not contain boron.

MACHINING DESK FAN PARTS

SPECIAL JIGS, FIXTURES AND TOOLS USED BY THE ROBBINS & MYERS CO., SPRINGFIELD, OHIO

SPECIAL jigs and fixtures that enable interchangeable manufacture to be handled economically and on a satisfactory basis are always of interest to the average mechanic, inasmuch as the majority of these methods can be applied directly to his own work. The manufacture of desk fan parts in large quantities, for instance, requires a special tool equipment that compares favorably with that used in any other line. A number of interesting devices and methods for this work have been devised by the Robbins & Myers Co., Springfield, Ohio, and a description of these will be given in the following.

Fig. 1. Jones & Lamson Double-spindle Flat Turret Lathes at work on Fan Motor Bodies

Machining Fan Motor Bodies on a Jones & Lamson Double-spindle Flat Turret Lathe

Fan motor bodies are made from cast iron and have a particularly thin wall, which makes them extremely difficult to machine, because of the tendency of the castings to spring out of shape when being clamped. Another difficulty is that of making the hole for the motor shaft absolutely true with the counterbore in which the field of the motor rotates. To machine one of these motor bodies satisfactorily, therefore, requires not only a first-class tool equipment for holding and machining, but also calls for great care on the part of the operator. Fig. 1 shows two Jones & Lamson double-spindle flat turret lathes set up and in operation on this class of work. The machine to the left is working on fan motor bodies, while that to the right is at work on the cover or end of the body. The machining operations on the body are the most interesting and therefore will be given here.

Fig. 2 shows a close view of the turret tools, etc., and also the chuck, and Fig. 3 gives a clearer idea of the construction of the chuck and the method used in holding the work. The chucks used are of the ordinary three-jaw type, carrying special cup-shaped housings *G* fastened to their faces as shown. Around the periphery of these housings are located six knurled headed thumb-screws *H*. The points of these screws bear lightly against the body of the castings after they have been tightly gripped on the bearing hub by the three jaws of the chucks. The holding and driving is done by the chuck jaws, the housings and knurled screws being used merely to steady the castings. The screws bear against the castings and are tightened just sufficiently to hold them from being shifted out of place by the thrust of the cutting tools. The order (see Fig. 2) in which the operations on this fan motor body are handled is as follows:

First, remove scale from large bore with two tools held in the turret.

Second, index turret; rough-bore and counterbore small holes and rough-bore large holes with tools held at *A* in the turret.

Third, index turret; rebore small holes with boring tool *B*.

Fourth, index turret; finish-ream small holes and counterbore with tools *C* floating; finish-bore large holes with inserted-tooth cutters *D* and finish-face end of casting with tools *F*.

While the double-spindle type of machine takes a little longer to set up for various operations, it has the advantage of turning out two pieces in the same time that one could be turned out on a single-spindle machine. As far as accuracy is concerned, the work produced comes up to requirements and, in fact, the Robbins & Myers Co. has found that the double-spindle machine is especially adapted for this class of work, as a product of sixty-eight completed bodies in ten hours should bear evidence.

Two-speed Milling Device

A two-speed milling device for operating two milling cutters of different diameters at their correct peripheral speeds is shown in Fig. 4. The part being machined is a one-horsepower alternating-current motor body which is face-milled and has a slot cut in its base at the same time. Two of these castings *A* are clamped to the milling machine table at one time and the bases are machined by a large inserted-tooth milling cutter *B*, driven in the usual manner. The slots are cut with an end-mill *C* driven by a special arrangement passing through the spindle of the machine and the large cutter.

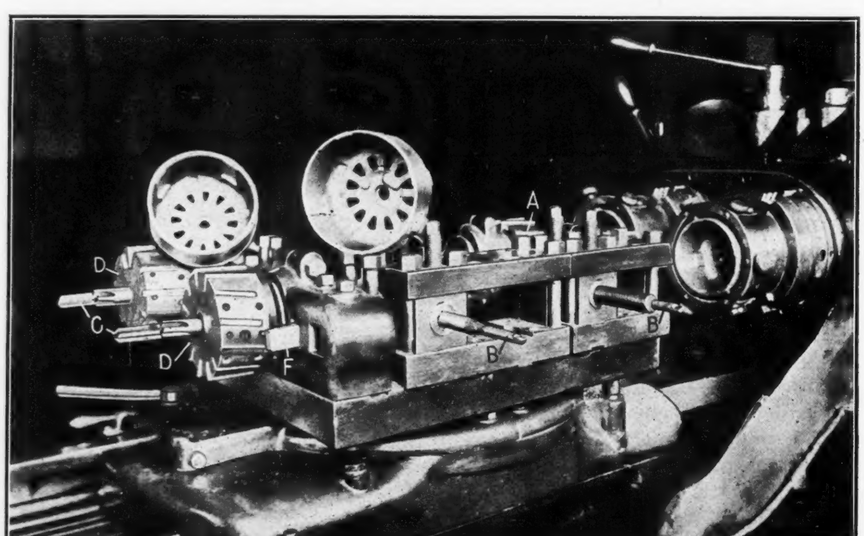

Fig. 2. Close View of Jones & Lamson Double-spindle Flat Turret Lathe showing the Turret Tools, Chucks and Work

A special spindle which passes through the spindle of the milling machine is supported at the outer end by the arm *D*, generally used for supporting the milling arbor, which, with the milling machine, as can be seen, has been reversed for this purpose. On this spindle a pulley *E* is located which is driven from the overhead works by a belt as shown.

The end-mill is screwed into the forward end of the spindle

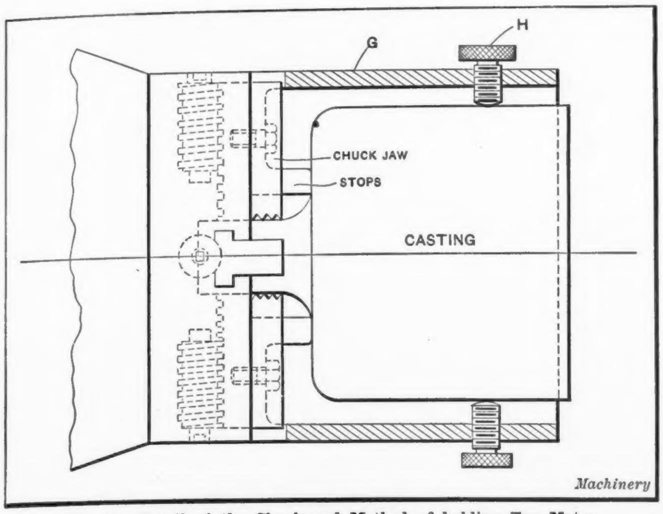

Fig. 3. Detail of the Chuck and Method of holding Fan Motor Bodies in the Two-spindle Jones & Lamson Flat Turret Lathe

and works in a hardened and ground bushing in the end. In the illustration, one of these bushings has been loosened and turned around so that the character of the operations accomplished can be seen and a better view of the cutters obtained. It is evident that it would be impossible to operate the end-mill at the same rate of feed as the large cutter, if the small cutter were rotated at the same peripheral speed. By giving the end-mill a proper peripheral speed, it can be operated at its proper cutting speed and the table of the machine given a rate of feed suitable for the large inserted-

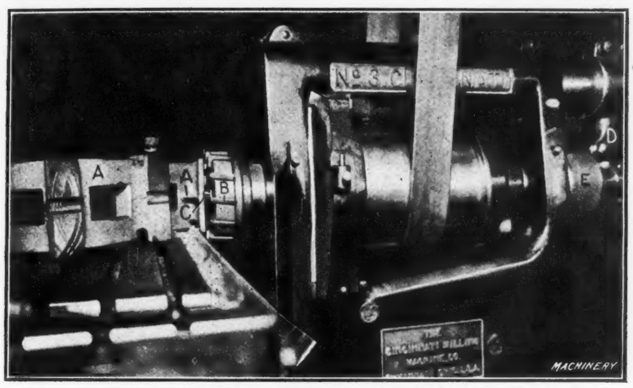

Fig. 4. Two-speed Milling Attachment for machining Alternating-current Motor Body Castings

tooth milling cutter, so that both cuts can be completed at the same time. This method of machining these motor bodies and the use of this special two-speed milling device may appear impractical to some mechanics, but, not having a milling machine of sufficient capacity to take care of the large variety of bodies and sizes, this company has used this method with very satisfactory results. Another method would be to mount the bodies vertically on fixtures on the table of the milling machine, and to use three spiral milling cutters of sufficient width, placing a milling cutter of the proper width for the slot between the two wider cutters. The entire operation could thus be accomplished in one cut.

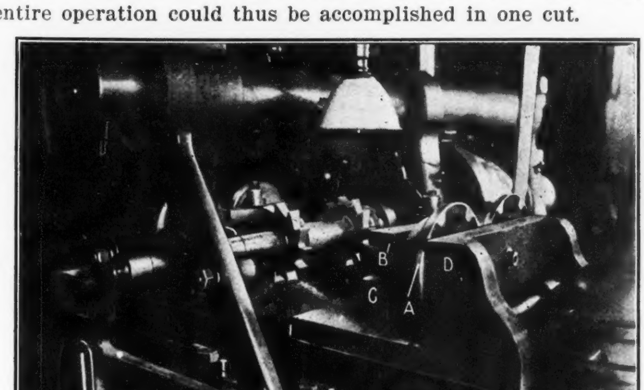

Fig. 5. Reciprocal Milling Attachment for machining the Slot in Desk Fan Bases

A Reciprocal Milling Fixture

Another interesting milling fixture is shown in Fig. 5. This is of the reciprocal type and is used for milling a 1 1/16 inch wide by 1 3/4 inch deep slot in desk fan bases. The spindle of the machine carries two side-relieved milling cutters 7 inches in diameter operated reciprocally on the four castings held in the two fixtures at each end of the milling machine table. While the cutters are at work on the two castings held in the fixture to the left, the operator is loading the fixture to the right and *vice versa*. The circular tapered bodies of the castings *A* are held by clamps *B* in V-grooves in blocks *C*. As the grooves are tapered to correspond with the taper on the work, the action of the clamps forces the base of the castings tightly against the face of the angle-plate *D*, holding them square and rigidly in position. This type of fixture gives very satisfactory results for this work and enables a

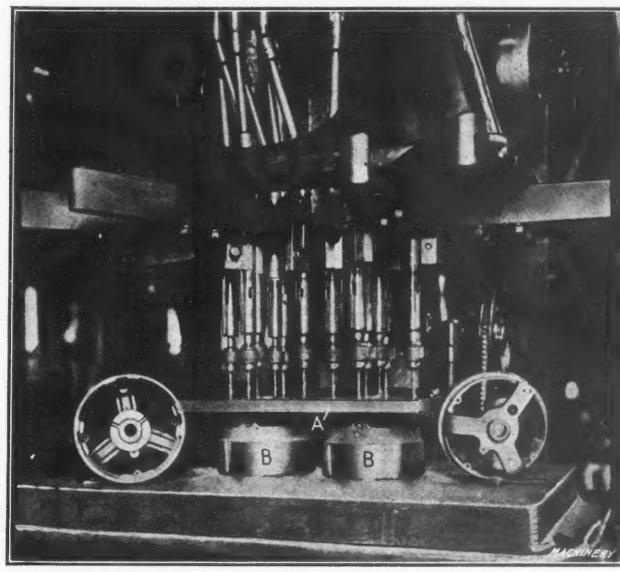

Fig. 6. Drilling Two Alternating-current Motor Bodies in a Pratt & Whitney Multiple Drilling Machine at the Same Setting

production of six hundred castings to be turned out in ten hours.

Gang Drilling on a Multiple Spindle Drilling Machine

An interesting fixture applied to a Pratt & Whitney multiple spindle drilling machine is shown in Fig. 6. This is used for drilling six holes in alternating-current motor bodies *B*, two castings being machined at the same time. The fixture, as Fig. 7 clearly shows, is of simple construction. It consists of a plate *A* which carries the drill bushings for guiding the drills, the motor bodies being located on central

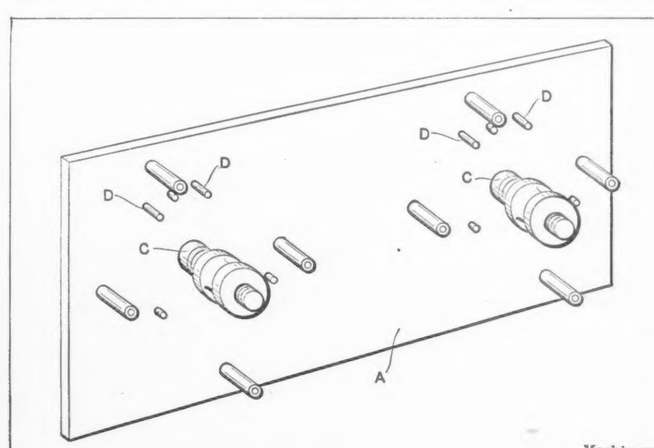

Fig. 7. Detail View of the Fixture shown in Fig. 6

guide studs *C* by two guide pins *D* in the proper positions from one of the arms. This type of jig is of open construction, easily cleaned, and enables the work to be removed and replaced very quickly.

Doubling Production on the Cleveland Automatic

Fig. 8 shows an improvement in tool arrangement on the Cleveland automatic for making the commutator shells shown

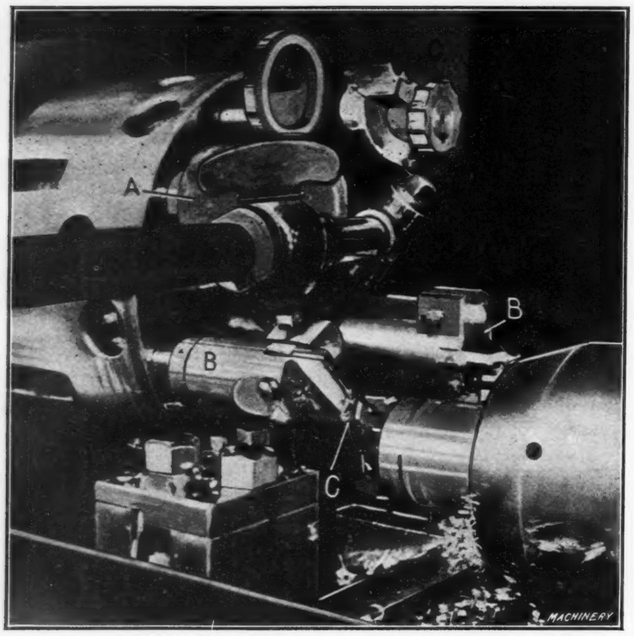

Fig. 8. Doubling Production on a Cleveland Automatic Screw Machine by having two Sets of Tools in the Turret

in Fig. 9, which are used on an automobile electric starter. These parts are made from a 3¼-inch bar of cold-rolled steel, and by the tooling arrangement shown in Fig. 8 the production was increased from 14 to 28 pieces per hour. The tooling equipment consists of two sets of tools carried in the turret and a form tool for producing or shaping two pieces instead of one at each stroke of the cross-slide. The order of operations is as follows: After feeding the stock out to the stop *A*, the hole is drilled and the bar turned by a combination tool *B* held in the turret; then by means of the combination reamer and counterbore *C*, the hole is reamed and counterbored in the front end to the beveled shape shown in Fig. 9. The cross-slide then advances and cuts the first formed piece off, after which the other set of tools comes into operation and forms another piece, two pieces dropping from the machine at every complete index of the turret. This method of doubling up the tools in the turret can be used to advantage on thin work of this type where only a few operations are performed from the turret.

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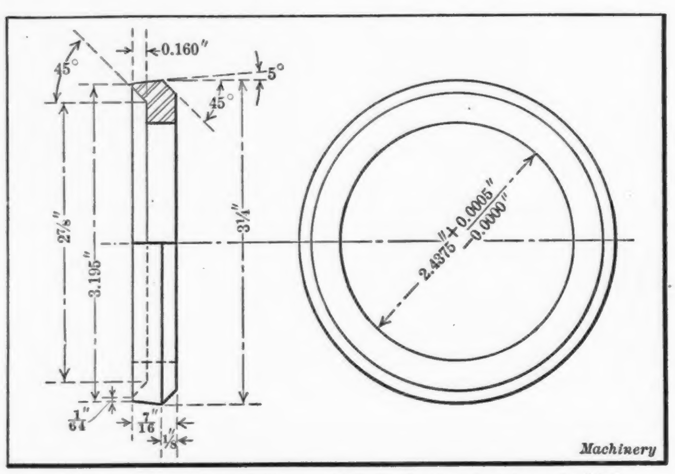


Fig. 9. Commutator Shell on which Production has been doubled on the Cleveland Automatic Screw Machine

* * *

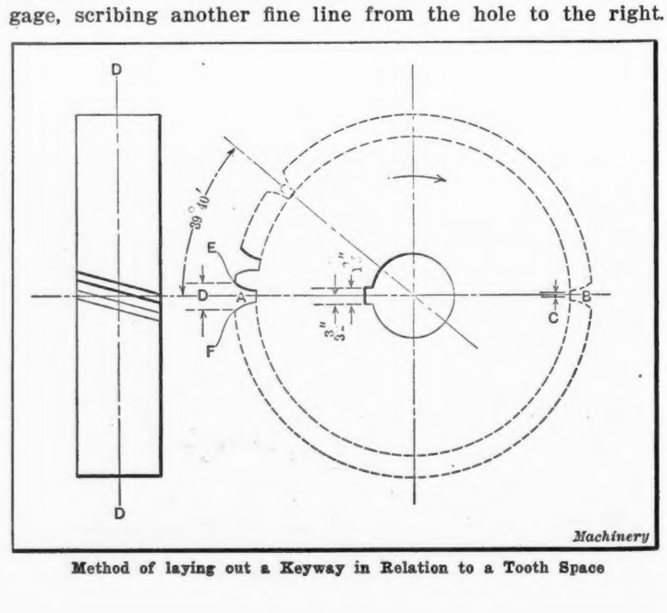
ACCURATE METHOD OF LAYING OUT KEYWAYS IN TIMING GEARS

BY ERNEST A. RUNGE*

Between the crankshaft and camshaft or the magneto driving shaft in an automobile motor, there are many places where errors may occur, the aggregate of which may seriously affect the timing. This makes it necessary—especially when building a model requiring the work to be done without special fixtures—for each keyway in the shaft or timing gear to be located very accurately. We have had quite a lot of this to do on model and special work, and have noticed that otherwise good mechanics have difficulty on this work through the lack of a good method. Believing that there are many others who do not get this kind of a job often enough to have worked up a simple and direct system of their own, I herewith describe the method we have followed with excellent results.

Let us suppose we have a timing as shown in the accompanying illustration, and for the sake of simplicity, let us for the present assume it to be a spur gear, the specifications calling for a 3/16-inch keyway located on the center line of the tooth space. The number of teeth is immaterial. Our first move will be to mount the gear, with the mandrel properly dogged, etc., on the index centers. If we have a true running expanding mandrel that fits in the index spindle, it will be somewhat handier than the solid mandrel. See that the index head is equipped with an index plate, one having a circle with the largest number of holes that will permit division in degrees being preferable for this purpose. With a surface gage having a very sharp pointed scriber, find the center of the gear; this is accomplished by approximating as nearly as possible and then, with the backlash in the index head taken up, scribe a short line near the edge of the gear, say at *A*. Then index the gear through one-half turn, which brings this line at *B*, and scribe another short line at this position with the same setting of the surface gage. If the setting is correct, the two lines will coincide; but should there be a difference *C* as shown, it will indicate that the surface gage scriber is either too high or too low. If this is found to be the case, adjust the scriber to bring the point exactly midway between these lines and repeat the test; when the line drawn on one side of the center coincides with another line drawn on the opposite side—the gear being indexed one-half turn as previously explained—we have found the center. Next we must find the tooth space represented by the distance *D*. With the surface gage scriber at position *A*, set the scriber point so it just touches the periphery of the gear, and index the gear around in the direction of the arrow so that the edge *E* of the gear tooth comes exactly to the scriber point. Mark the position of the index crank with the index sector. Now move the gear around until the edge *F* of the next tooth comes exactly to the scriber point. Count the number of holes passed over in the index plate. Let us suppose we count twelve holes; then the distance *D* requires twelve holes, and one-half of this or six holes will give us the point midway. Now return to *E* and index that number, and we have brought the gear to the position shown in the illustration.

We can now lay out the position of the keyway by adjusting our scriber point 3/32 inch above or below the center, and scribing a fine line from the hole to the left as shown; then indexing the gear around one-half turn, bringing *A* to position *B;* and then with the same setting of the surface gage, scribing another fine line from the hole to the right.



Method of laying out a Keyway in Relation to a Tooth Space

* Address: 110 Boulevard, Hartford, Conn.

The two parallel lines thus obtained mark the location of the keyway. If the keyway is to be cut in the shaper, an additional center line at right angles to *A—B* will be of service in setting the gear in the shaper vise, as by our method we set the gear with this vertical center line parallel to the vise jaw and carefully guide the tool between the lines scribed for that purpose, until we arrive at the proper depth. If care has been exercised in the previous operations, you will have the keyway located as accurately as is possible without an elaborate special fixture. It is assumed that unless you are blessed with unusually good eyesight, you will use a magnifying glass to assist in making these settings. Had the drawing called for a keyway to be located in a position 39 degrees 40 minutes measured counter-clockwise from the center of the tooth space, after we had found the center of the tooth space, we would have indexed the gear that amount in the direction of the arrow, which would bring the tooth space center to position marked *G*. The keyway would then be laid out as before.

In the previous examples we have assumed the gear to be a spur gear. Had it been a helical gear, if the layout for the keyway is shown on the side, our method would be the same as for a spur gear, except that in finding the center of the tooth space we would be obliged to work entirely on the side of the gear. A moment's consideration will show why this must be. The layout may be shown on a plane at the center of the gear width as indicated by the line *D—D;* only one helical cut is represented to avoid confusion. In a case like this, before mounting the gear on the mandrel, we would scribe a line *D—D* on the ends of the gear teeth. Then after the gear is in position, to find the center of the tooth space as in the previous examples, we set our surface gage scriber point exactly on this line *D—D* and find the center of the tooth space as before. Having found the center, scribe the line across the side of the gear and proceed the same as for the spur gear. Had it been necessary to work from the center of a tooth instead of a tooth space, the procedure, except for this difference, would have been the same.

* * *

FIXTURE FOR MILLING CLUTCHES

BY I. W. SPRINK*

The accompanying illustrations show the design and construction of a special form of dividing head used for cutting the clutches on transmission drive pinions and sliding gears.

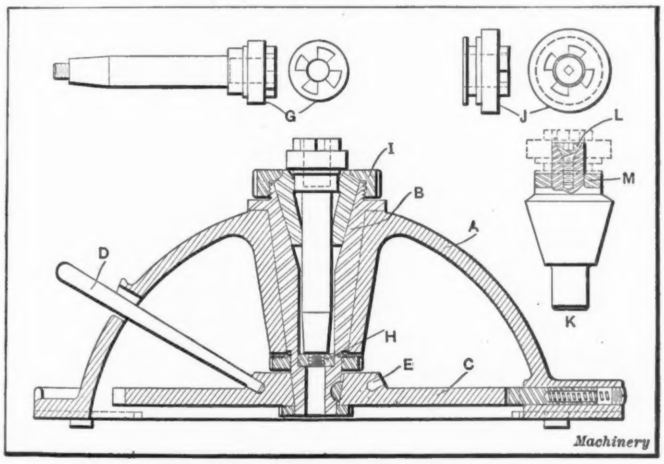


Fig. 1. Cross-sectional View of Fixture for milling Clutches and Details of Work-holding Mandrels

This fixture consists of a frame *A* into which the spindle *B* is fitted. The spindle is designed to serve as a collet chuck on the upper end and is arranged to carry the large index plate *C* at its lower end. The method of operating this dividing head is very simple, the spindle being rotated by means of the handle *D*. The index plate has a series of holes *E* drilled in it at a convenient angle to receive the handle *D*. To turn the spindle, it is merely necessary to withdraw the locking bolt *F* by means of the small lever provided for that purpose, and move the index plate around by means of the handle *D*.

* Address: 3209 McKinley Blvd., Milwaukee, Wis.

The method of chucking the pinion shaft *G* is clearly shown in the cross-sectional view, Fig. 1, and will need little description to make it clear to any mechanic. It will be seen that a small collar *H* rests in a hole at the bottom of the spindle; this collar receives the downward thrust of the work and also serves the purpose of locating the lower end of the work to bring it exactly perpendicular. In using this fixture it is customary to put a sheet-metal washer between the lower face of the pinion and the top surface of the chuck ring *I* in order to keep chips and oil from running down into the dividing head. The collet chuck is cut into three parts and provided with springs between its faces to expand the collet.

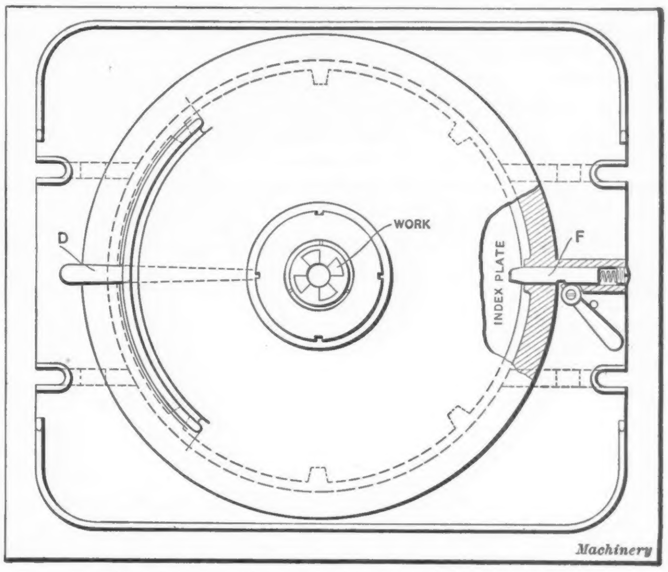


Fig. 2. Plan View of Fixture for milling Clutches

When milling the clutch gear *J* the split collet is replaced by the expansion chuck *K*. The body of this chuck fits into the spindle and is locked in position by the chucking ring *I*. The work is held on this chuck by expanding it by means of the taper headed screw *L*, which is turned by a square key. The hardened steel collar *M* is fitted onto the chuck to provide a good bearing surface and resist wear. The clutch gear is shown in position on the chuck by dotted lines.

It will be evident that eight cuts are required to complete the milling operations on one of these clutch gears, and consequently it is necessary to use an eight-point index plate. A cutter ½ inch wide is used. After setting to bring the cutter to the required depth, the milling machine saddle is moved in until one edge of the cutter registers with a point 0.010 inch to the left of the center; four cuts are then made, completing one side of the clutch teeth. To mill the other side of the teeth, the milling machine saddle is moved out until the other side of the cutter registers with a point 0.010 inch to the right of the center. The head is then indexed ⅛ revolution to mill the side of the first tooth, and then ¼ revolution for taking each of the three remaining cuts. The clutch teeth are cut a little off center in order to give the clutches the required amount of clearance.

All steel parts of this dividing head are carbonized, hardened and ground to make a good serviceable tool. The ideas embodied in the design of this special dividing head may suggest other uses for a tool of this kind where it is required to perform milling, drilling and other operations on work for which the regular milling machine dividing head is not suitable.

* * *

What is claimed to be the largest wind motor in the world has lately been erected at Harlingen, in Holland, for draining a tract of lowland redeemed from the sea by high embankments, the area being nearly 2000 acres. This wind motor is provided with steel sails and is mounted on a steel tower. It has a diameter of 50 feet. It is an interesting fact that while some years ago the wooden windmills of Holland began to be replaced by internal combustion engines, during the last five years the steel windmill has begun to be more and more employed, especially for pumping purposes.

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THE PROBLEM OF DISTRIBUTION

The greatest problem confronting society is that of distributing the products of factory, mine, farm, and every industry more efficiently, which means at less cost. Scientific management has done wonders in reducing the cost of manufacture, but it is of little avail to cut the cost of manufacturing products when the great cost of distribution remains practically unchanged. The disparity in the price of farm products in the city and country is notorious. What is needed is some better means of bringing producer and consumer together.

Manufacturers spend money liberally to bring their products to the attention of possible customers, and it must be counted a great achievement of advertising that some great businesses have been developed very largely by its aid. But while it is true, and of course perfectly natural, that a man will read advertisements which describe the tools and materials of his own trade or business, and about anything in particular which appeals especially to him in a personal way, it is true also that the advertising of general products is not habitually read by the general reader as the editorial pages are read. This is one of the great problems of distribution, but we believe it is in course of solution. The old suspicion of advertising claims and statements is wearing away. Advertising has gained greatly, not only in good taste and in the ability to impart information, but also in the reputation for reliability.

The columns of the foremost newspapers, the leading magazines and technical journals are open only to the advertising of reputable people whose claims are scrutinized, and no reader of important journals can now afford to neglect the advertising. Speaking of technical journals in particular, the reader who regularly consults the advertising acquires a great deal of valuable technical information, a knowledge of new developments and considerable trade information which can be acquired in no other way. The day is not far distant, we believe, when the advertising pages of MACHINERY, for example, will rival the reading pages in presenting news of improved practice, materials, machines and designs. Stilted catalogue advertisements devoid of life and drawing power will be entirely displaced, as many of them are now, by masterly argument and convincing claims that will make the silent salesman—the technical journal—an even more potent factor in the great problem of distribution.

HERRINGBONE GEARS FOR HEAVY DUTY

In the beginning of mill construction the gearing was made with wooden teeth, and this form was slowly displaced by cast-iron gears with integral teeth, molded from a full pattern. These cast gears, however, were inaccurate and noisy. The patternmaker might make the pattern with thoroughness and skill, but it was soon warped by rough usage in the foundry and the influences of the weather. A great improvement in cast gears was effected by the molding machine which eliminated the tooth inaccuracies inherent in the full pattern. A pattern of one tooth only, indexed step by step, formed a mold in the sand with precision, and thus eliminated the troubles and expenses incident to the use of the old full patterns. But the requirements of modern machinery construction were not always met satisfactorily in cast teeth, and so the final step in spur gear making was effected when machines were built for forming the teeth from the solid metal by formed cutters or generating tools. Today spur gears twenty-five feet in diameter and larger are machine cut, but this stage, too, is but another step in the evolutionary process.

The spur gear drives its mate evenly or unevenly, depending on whether or not its tooth forms are true shapes. If the shapes are true, if the gears are correctly mounted and if they are not overloaded the angular motion transmitted will be regular, but ideal conditions are difficult to realize in the beginning and almost impossible to maintain.

The inherent defects of spur gearing are being more and more realized as the requirements of machine users become more and more rigid, and designers are specifying herringbone or double-helical gears for positions in which spur gears have proved unsatisfactory. The smooth running characteristic of the double-helical gear is no new discovery. On the contrary, it has been known a long time, and this type of gear has been much used, but only when its higher cost was warranted by the conditions to be overcome. Now, however, the difference in the cost of spur and herringbone gears is becoming less and less as improved processes are being applied to the production of the latter. As some one has aptly remarked, the herringbone gear is to the spur gear what the cut gear was to the cast gear. That, in a nutshell, tells the story of evolution.

* * *

ALLOY STEEL GEARS IN MACHINE TOOL CONSTRUCTION

Considerable experimenting has been done by machine tool builders in an endeavor to follow automobile manufacturers in the use of alloy steel gears in gear-boxes and other power transmitting units of machine tools in order to prevent breakage and stripping of gear teeth. Alloy steel, such as chrome-vanadium and chrome-nickel, has been used with more or less success. Where it is impossible to make a complete analysis of the steel before working it up, it has been found that alloy steel gives far more trouble than ordinary carbon steel. The limits of fluctuation in heat-treatment are much narrower than in ordinary carbon steel, and the material must be handled much more carefully if good results are to be expected. One machine tool builder in the Middle West has tried both chrome-vanadium and chrome-nickel steel for gears which are used in a gear-box transmitting considerable power. Very unsatisfactory results had been obtained, and this manufacturer has gone back to the use of ordinary carbon steel having a carbon content of 0.20 per cent, heat-treating the gears in the most scientific manner known. Since using carbon steel this company has found that its troubles in the way of breakage and stripping of gear teeth are practically eliminated. A more uniform carbon content, in ordinary carbon steel, is obtained; and hence the same heat-treatment on different classes of gears can be employed with very little loss. This seems interesting, since the development, of late, has pointed rather to the use of chrome-nickel and chrome-vanadium for gears that are required to work under severe conditions of load, speed and shock.

FORCED FITS

Periodically, in the transactions of engineering societies and in the technical press, discussions appear with regard to the proper allowances for making forced or pressed fits with full holding power and maximum economy of metal. There seems to be no such uncertainty with respect to shrinkage fits—a confidence which is justified fully by their extensive use in all built-up ordnance. The integrity and safety of every high-powered gun, in all armies and navies, depends upon shrinkage allowances, and the total absence of accidents in recent years through the bursting of the breech in such guns proves that these allowances are adequately proportioned for the stresses which the compound cylinder forming the breech must meet when the charge is exploded. The thickness of these cylinders and their relative "allowances"—that is, the difference before shrinkage between the external diameter of the inner cylinder and the internal diameter of the outer—are always based fundamentally on Lamé's formula for the determination of the stresses in thick cylinders. The derivation and application of this formula have been fully discussed in previous numbers of MACHINERY.

If the allowances for the forced fit are so proportioned that, in pressing home the inner member—axle, shaft or crank-pin—into the outer member—wheel-hub or crank—there occur only expansion of the latter and compression of the former, both within the elastic limits of the metals, then Lamé's formula is fully applicable to forced fits also. Let us consider the effects which, by this formula, are shown to be caused by shrinkage and on the assumption as above by forcing also.

The radial pressure on the contact surfaces of the fit produces a radial, compressive stress in both the inner and outer members. As a result of this stress there are induced in the outer member a circumferential tensile stress or "hoop tension" and also, through lateral contraction, a longitudinal compressive stress which, in wheel or crank-pin hubs, is negligible. The hoop tension diminishes in intensity very rapidly from the inner to the outer circumference of the hub, and hence the critical and dangerous part of the fit lies at the inner layer, that is, at the bore. So long as the tensile stress in this layer does not exceed the ultimate tensile strength of the metal, the hub will not burst, and, conversely, no hub thickness whatever will prevent rupture if the ultimate tensile stress of the metal at the bore be exceeded. Further, as the radial stress decreases so rapidly toward the outer circumference, the influence of wheel-arms and crank-webs on the resultant hoop tension is relatively slight. The allowance per inch of diameter of the inner member depends upon its coefficient of elasticity, the allowable tensile stress at the bore and the quotient of the true compressive stress at the outer surface of the inner member, divided by the hoop tension at the bore. The holding power of the fit is the sum of the total radial pressures on the contact surface, and this pressure is, in turn, affected by the size of the allowances and the compressibility and expansibility of the inner and outer members, respectively, the expansibility depending to some extent on the thickness of the hub. As increased diameter gives augmented contact surface, the allowance per inch of diameter may be decreased if the holding power required does not increase proportionately with this surface.

While the basic principles governing shrinkage and forced fits are the same, the methods of making them differ, and hence there is some doubt, especially with large allowances, as to whether the formulas for a shrinkage fit apply fully to the forced fit. With the latter, in driving the inner member home, the effective allowances and holding power may be reduced either by abrasion or, with unduly large allowances and ductile metal in the hub, by an axial flow of that metal in advance of the entering inner member. There seems no question, however, that with metals of average stiffness, the allowances in forcing should not exceed those for shrinkage, as otherwise there will be at the bore either excessive stress, permanent set or rupture, with ultimate failure of the fit.

OPPORTUNITIES FOR THE MACHINIST

BY F. B. JACOBS*

Anyone who has associated with machinists to any extent cannot help but realize that they are sometimes discontented with their prospects in life. When the machinist compares his wages and outlook with those of his fellowmen who are employed at other vocations, he naturally draws conclusions, which may, or may not be logical. In interviewing a number of machinists, we find some that are satisfied and contented. On the other hand, many claim that their wages are insufficient when compared to the rates paid in other skilled trades, and that life offers no better prospects than uninteresting daily toil for years to come. It cannot be justly claimed that all forms of discontent are harmful, for ambition and discontent often go hand in hand, the one being the direct cause of the other. The dissatisfied machinist has a vague idea that he would like to work at some other calling, but for some unknown reason the majority, when discussing the subject, seem to have a leaning toward vocations for which they have had no training. However, an examination of the ideas advanced shows the same desires: *viz.*, greater compensation for energy expended, less manual labor and more leisure time. We cannot claim that these desires are unreasonable, for they have been, and always will be, entertained by useful citizens in all walks of life. How about the machinist? What chance has he in the competitive struggle? Twenty-five years of close association with machinists and machine shops has convinced the writer that the machinist has a better chance than the average worker and the conclusions drawn are taken from actual experience. The word "worker" is used in this case to designate anyone who is not possessed of an independent income.

In considering the wages paid machinists, we must not lose sight of the fact that they are regulated by the inflexible law of supply and demand. As an illustration, if there are ten open positions at $3.50 per day, and fifteen idle machinists to fill these positions, it is evident that not one of the fifteen could reasonably expect more than the current rate. On the other hand, if there were only five available men, it is evident that some of this number would succeed in getting a higher rate, depending, of course, on their ability to sell what they have to offer—their labor.

When considering the wage question there is another fact that is often overlooked by the mechanic; that is, the close competition that exists between manufacturers whose products are identical. Let it be assumed that two concerns are engaged in the manufacture of machine tools—lathes, for instance. They both buy material in the open market at practically the same prices, the shop management is as efficient as possible, the selling methods are the same, and the combined output goes to the same market. In both cases the selling prices must be practically alike for tools of like design and purpose. It is a well known fact that labor is the most expensive factor in any industry; therefore one concern cannot pay more than the current rates for skilled mechanics and dividends to the stockholders at the same time.

In comparing machinists' wages with those paid other skilled workers, we must take equal conditions, considering carefully the amount of skill involved, the number of available working days per year, the personal risk encountered, and in some cases the physical strength required. A die-sinker receives high wages because his work calls for a combination of mechanical skill and artistic ability. A toolmaker is well paid, as it calls for more than ordinary skill, together with long practice, to work to close limits. An experimental hand, that is one who constructs initial machines from drawings without the aid of jigs, is well paid, as it takes more than ordinary ability to become proficient at this class of work. It is not logical to compare machinists' wages with the rates paid to those employed in the building trades, carpenters, masons, tile setters, structural steel workers, etc., because these trades do not give steady employment owing to inclement weather and off seasons. While the building trades are well paid, their members are seldom better off,

* Address: 838 North Capitol Ave., Indianapolis, Ind.

year for year, than the machinist. Their only gain is too much leisure time. This is a serious setback from a financial point of view, as one always spends more than usual while unemployed, that is if one has it to spend. Structural steel workers are well paid because their work involves the daily risk of life and limb. Perhaps the highest paid skilled workers are the rollers employed in steel mills. They receive from $8 to $15 per day, depending on the material rolled. This work calls for unusual strength, great skill and a sure eye and hand—hence the high wages. In all the callings mentioned it would be comparatively easy to obtain workers at low rates if more than enough men possessing the necessary qualifications were constantly in the ranks of the unemployed. That high priced men find ready employment at the above-mentioned trades is due to the fact that they possess certain qualifications not found in the average person.

On the other hand, the machinist receives better compensation for the time and effort spent than many other skilled workers. As an illustration we can consider the furniture workers of Grand Rapids, Mich., or Evansville, Ind. These are two of the largest furniture manufacturing centers in the country. While the component parts of any piece of furniture have to be accurately machined, the work is of a semi-automatic nature. As it is routine work any man can become skilled in a short time, provided he possesses a certain amount of mechanical ability. For this reason the wages paid are comparatively low, as men who could become qualified and who would be willing to work for moderate wages can easily be obtained.

Coming back to the direct subject: How is the machinist to better his condition to the extent of increasing his compensation? There are many ways. For example, instead of being an ordinary hand on uninteresting routine work, why not be an expert all-around man? The work is interesting and the wages good. While the way to success is somewhat rocky, it has been traveled by many and the skill attained is sure to be recognized sooner or later. When a machinist has once earned the reputation of being a skilled and reliable workman, the fat pay envelope becomes a reality instead of a dream. There are three primary qualifications, good health, mechanical intuition and the love of adventure. It is an acknowledged fact that shop practice varies greatly, not only locally, but all over the country. For this reason, it is necessary for the man who desires to become an expert to follow the wanderlust for a period of years. This involves working on all sorts of machine work in many localities. The scene of activities often includes every large city in the country. The life is hard in many ways, calling for a cast-iron constitution. Days of misery are sure to be encountered; there will be times of sickness among total strangers, or what is worse, no money. It is well to mention these facts in passing; otherwise one might form the opinion that the life of the roving machinist is a bed of roses. It is worth while, however, as the experience gained by travel and association is invaluable. After a machinist has worked in thirty or forty shops he should be a good mechanic if it is in him to be one.

No system of training is without its drawbacks, and the schooling received by the wandering machinist is no exception. Often times the wanderlust is irresistible to one who has once answered it. This is especially true during the first balmy days of spring. The stay-at-home hears the same call, but he lacks the courage or initiative to answer it. The result of answering the call is that many mechanics never settle down. This is true of the minority only, for the roaming machinist is very like his stay-at-home brother in one respect; he cannot, or at least does not, resist the feminine charms. Thus he generally marries, and home ties eventually compel him to settle. He is careful where he settles, however, as experience has taught him to compare conditions and to form accurate decisions as to what constitutes fair treatment, wages, etc. His varied training has developed initiative. Therefore he knows how to proceed in selling his labor to the best advantage. Those who have been trained in the school of experience seldom try to stir up trouble when unfair shop conditions, real or fancied, are encountered. If dissatisfied they remedy the situation very simply by following the line of least resistance—they seek employment elsewhere.

It is sometimes argued that under present conditions a varied training is not necessary, that we are in an age of specialization, etc. Perhaps we are. Nevertheless the fact remains that men who have had the varied training on actual work invariably succeed in obtaining responsible positions at good wages. There are several kinds of varied training. The college trained mechanical engineer is one example. That he is college trained is due to the fact that his parents were financially able to not only support him, but pay expensive tuition fees during a period of his life when his earning power was absolutely nil. We respect the college man because he has had a varied training along theoretical lines. Thousands of dollars have been spent on his education. Why was this done? To fit him for his life work and to make him a useful member of society. The practically trained man is respected because he has shown ability to fight his own way, thus making possible a varied training. He has asked no favors of anyone. Not only has he made his success possible, but he has also been a producer the meanwhile. Who deserves the greater credit, the one who had the way paved for him, or the other who fought his own way?

It is sometimes claimed that the machinist's opportunities for betterment would be greater if his labor organization were stronger. If the test of time is of any value, it would appear that this theory is not well grounded. To be sure, card men are conspicuous in the Western and Southern states; indeed a non-union man finds it almost impossible to obtain employment in these sections. The South and West, however, contain comparatively few manufacturing centers. Taking the country as a whole, the majority of the employers of machinists run strictly open shops. If one happens to be a card man he is not molested. On the other hand, card men are not permitted to intimidate or cajole their fellow workers who are not organized. As a matter of fact non-union men often receive higher wages than those paid under the rates set by the union scale. Organized labor automatically adjusts itself to conditions; we do not have to consider it theoretically, as known results give us the base on which to frame our arguments and draw our conclusions. The wandering machinist is always a card man; necessity compels him to be. However, at the same time, he generally favors the open shop, whether he acknowledges it or not, as it is there that he receives the highest compensation.

Is the machinist better off, financially and otherwise, in the city or country? This question must be viewed from many points. That the city offers greater opportunities for employment cannot be denied. The cost of living in cities is, of course, greater, but to offset this wages are higher. Many live in the suburbs, traveling back and forth daily. This consumes time and incurs an extra expense, but it is argued that the advantages gained by living away from crowded districts outweigh the extra time and expense. If one is employed in a comparatively small town, the cost of living is much less than it is in the city. On the other hand, one is practically tied down, especially if he happens to be a property owner. Under these conditions the shop management is in a position to exercise a dictatorship even to the extent of controlling the political rights of the workman. In the small town the union does not set the rate—the shop management does. Thus one might be ever so skilled or efficient and yet find it impossible to obtain more than the fixed rate.

One reason for this, and a logical one, too, is that in a comparatively small town everybody is acquainted with their neighbors' affairs. Let it be assumed that Bill succeeded in getting an increase of twenty-five cents per day. Naturally he tells Mrs. Bill, for ten chances to one she would find it out anyway, and if he had not enlightened her at first there would be domestic warfare for the time being. Now Mrs. Bill is very much pleased. An extra $1.50 per week that was not looked for will go a long way. She may get a new hat, who knows? She cannot resist the feminine tendency for gossip to the extent of keeping Bill's good fortune to herself.

She tells Mrs. Jim and what is the result? Mrs. Jim, of course, tells Jim when he comes home to dinner. He gets peeved and thinks that he, too, deserves a raise. He may get it, and again he may not. However, it soon gets noised around that Bill has had his pay raised, and the first thing the management knows they are confronted with a general demand for more money. This could not happen in a city, for city people are master hands at attending to their own affairs; indeed they seldom know their next-door neighbors. In a small town, the shop management is shrewd enough to realize that the workman cannot, or at least does not, care to incur the expense of moving to another locality. Another reason why many hesitate to locate in country towns is that there is very little to offer in the way of recreation, aside from a moving picture show or two. All work and no play makes Jack a dull boy; therefore the machinist cannot be blamed for working in places that have at least the appearance of being lively.

After all is said, the machinist has as many opportunities as any other worker, if he will take steps to turn chances into success. No one can reasonably expect to succeed by waiting for fortunate chances—these have to be sought.

* * *

COOPERATION OF THE FACTORY MACHINE SHOP WITH THE TRADE SCHOOL*

BY JAMES F. JOHNSON†

In the present move toward supplying the demand for trained mechanics through trade education departments, it is timely to note the important part that can be played, and really should be played, by factories having trade apprentices. The apprenticeship system has about passed out of existence. Because of the general trend of manufacturing competition, every effort is brought to bear upon production and the idea of taking the time of a valuable producer to instruct young apprentices who are not producers of any great worth does not usually appeal to the manufacturer. Because of this state of affairs, the apprentice is obliged to learn his trade as well as he can. The result is inevitable, and surely cannot be considered valuable in building up the trade.

The opportunities offered by the trade school at Bridgeport, Conn., have brought about cooperation with the manufacturers that has proved an excellent way of dealing with

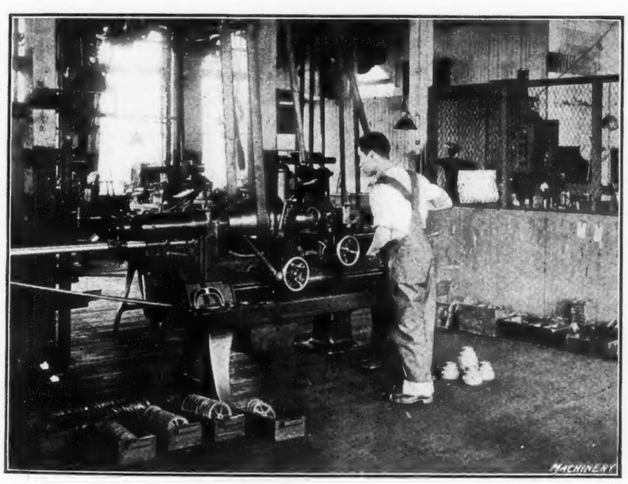

Fig. 1. An Apprentice learning to set up and operate a Hand Screw Machine

this important problem. What has been done there should encourage other industrial centers to make an effort in this direction. In order that those young men who are at work daily might enjoy the benefits of a trade education, there was opened up in the trade school a department for those apprentices who are employed in the shops outside. These young men attend the school five hours per week, fifty weeks in the year, during the length of their apprenticeship in the factory, and are paid by the factory while they are at school.

Instruction is given in those branches directly related to their trade but which cannot be given in the factory. The scheme is a praiseworthy one and those manufacturers cooperating in such a cause are to be complimented. The work as it is carried on for the machine apprentices is of most interest to the readers of MACHINERY and is here described. Fig. 1 shows an apprentice being instructed in screw machine operating, and Fig. 2 shows one of the ten divisions of machine apprentices coming from different shops. These are instructed in blueprint reading (the blueprints of the respective shops being used), shop drawing and shop mathe-

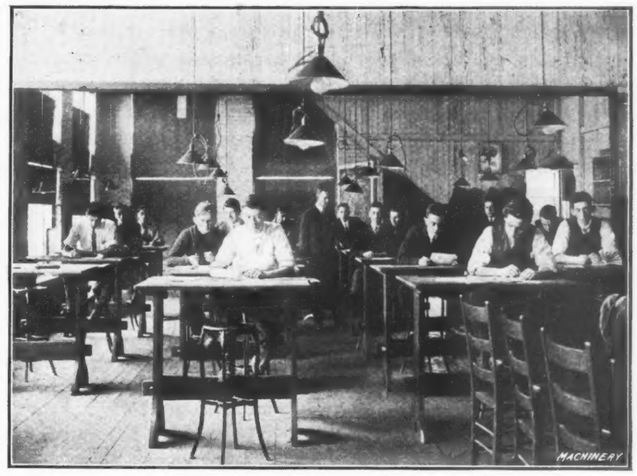

Fig. 2. A Class of Apprentices employed in Factories, who attend School One-half Day a Week

matics. Besides this, a portion of each session is set aside for the reading of trade literature, or for shop talks. Little if any instruction is given in actual machine work, as their respective shops will furnish enough of that—but what is needed most and what the factories do not give is what is taught in the school. The work is in charge of a thorough tradesman who appreciates the needs of the machinist.

Each week this instructor visits the shops where these boys are employed and secures such information as may be of value to him in his work. The great value of this instruction to the coming tradesman is daily illustrated in the places where the boys are employed. It is not an unusual thing to see one of them and the assistant foreman or the foreman with their heads together talking over features of a design shown on a blueprint. When there is doubt about a calculation in the shop, the student-apprentice is consulted, or rather he is given the work to do.

The spirit of cooperation between the tradesman and the apprentice is growing. The old hand at the trade smiles at the youth and slaps him encouragingly on the back, and he is given his place among the workers, for he is becoming an intelligent mechanic. This training carried on for the length of his trade apprenticeship is sure to have a very desirable effect. Besides being a machinist, he knows the whys and wherefores of things and is a more valuable man to himself and to his employer. As a result there will be among the coming machinists a group of young intelligent workers who thoroughly understand their trade and its relation with allied trades, and realize their position in the manufacturing world. The effect of this is undeniably good. It means a better workman, a better product, increased production, and better working conditions.

* For additional information on the subject of industrial education published in MACHINERY see also "Rational Methods in Engineering Education," March, 1914; "The Advantages of Manual Training Schools," March, 1914; "A Trade School Product," January, 1914; "Wood's Apprentice Industrial School," December, 1913; "A New Zealand School Workshop," November, 1913; "A Modern Apprenticeship System," June, 1913; "Development of Skilled Mechanics," June, 1913; "A School that Trains Boys for Shop Work," June, 1913, and other articles referred to in connection with the last mentioned article.

† Director, State Trade Education Shop, Bridgeport, Conn.

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A New Zealand correspondent writes that he considers it a serious mistake on the part of advertisers of American machine tools not to quote prices when advertising, and that the names of foreign agents or dealers handling their goods are seldom given. As a result the larger part of New Zealand business goes to English agents in New Zealand, much of which might be secured by American concerns if they displayed a little more enterprise in advertising, giving prices, the names of foreign representatives, and other specific information.

MAKING CON-ECCENTRIC TAPS*

METHOD USED IN CUTTING RELIEF ON TAPS LEAVING PART OF THREAD CONCENTRIC

BY SERVER

I HAVE been particularly interested in reading the articles which have appeared in MACHINERY on machine relieved taps, and feeling that a brief discussion of the method of machining this relief would be of interest to others, I have prepared the following article. In conducting this operation, certain difficulties are met with in connection with "picking up the thread" preparatory to relieving the lands of the taps, and in connection with a description of the method of conducting this operation I propose to explain a few short-cuts which greatly simplify the work. A number of tap-makers seem to have recognized the con-eccentric relief for taps as most satisfactory, and apparently each of these manufacturers has been using this method secretly in the belief that his product was the only one embodying this valuable feature. Under the pressure of business competition, this fallacy has been exploded, thus meeting the fate of the majority of such business and trade secrets. The information given in this article applies particularly in cases where special or small lots of standard taps are put through. The methods described are in no sense representative of standard practice in the manufacture of taps on a commercial scale, as plants engaged in this line are equipped with more or less special machinery for cutting the threads. Machines used for this purpose are semi-automatic in operation, the operator being merely required to set the work up in the machine and to see that it operates properly.

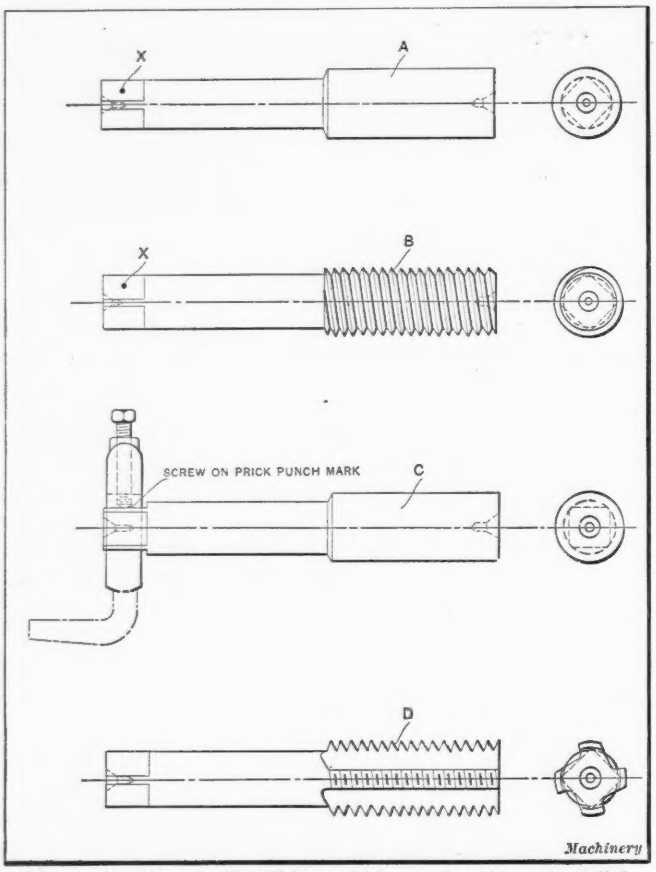
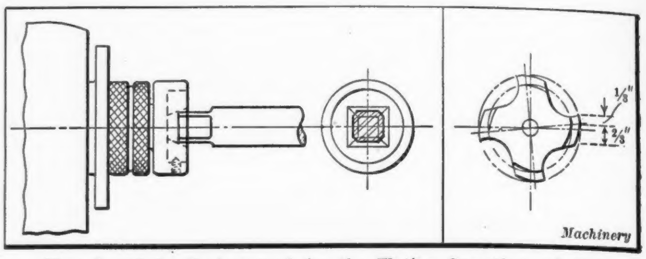


Fig. 1. Operations in Tap Making which precede cutting the Relief

Fig. 1 shows the preliminary operations involved in making a tap according to the methods which are outlined in the following. Previous to cutting the thread and relief, the taps are first machined to the form shown at *A*, with the



Figs. 2 and 3. Centers used for the Fluting Operation and End View of Finished Tap showing Con-eccentric Relief

square cut on the end of the shank. Before starting to cut the thread it is a wise precaution to place a prick-punch mark or other point of reference on one side of the square, as indicated at *X*. This mark comes under the screw of the dog, as shown at *C* in Fig. 1; and the reason for observing this precaution will be explained in a subsequent paragraph. Each tap is next placed in the lathe to have the thread cut in the usual way, no attention being paid to the matter of relief. After the threading operation has been performed on each of the taps, they are set up on the milling machine to have the flutes cut, which brings the work to the condition shown at *D*. In performing this operation care is taken to have the prick-punch mark previously referred to, in line with a suitable mark on the spindle of the indexing head, if a center similar to the one shown in Fig. 2 is used. In case the work is mounted on centers and driven by a dog, the screw of the dog is brought down on the side of the square having the index mark. The reason for always placing the dog on the square is the necessity of having the flutes on each tap in the same relation to the thread. If there are either four or eight flutes on the tap, however, it is unnecessary to follow this method as the relation of the flutes to the helix will be the same on each tap regardless of the position of the prick-punch mark. In any case, the reference mark would be placed on one side of the square, as it is used again in a subsequent operation.

So far as their appearance goes, the taps are now finished. In order to make them cut more freely, however, it is the practice to make them with one-third of the land concentric and two-thirds eccentrically relieved. Fig. 3 shows an end view of one of these con-eccentric taps, from which the method of relief will be readily understood. To machine this relief, the taps are returned to a lathe fitted with a special relieving attachment connected to the cross-slide. The drive is obtained by gears and a shaft which actuates a cam that causes the cross-slide and threading tool to move in on each land to produce the eccentric relief, and then come out again ready to engage the next land. The general arrangement of the relieving attachment is shown in Fig. 5. In machining the relief, the cross-slide moves in the direction of the arrow, this movement being controlled by the cam on the driving shaft; the cross-slide is held in contact with

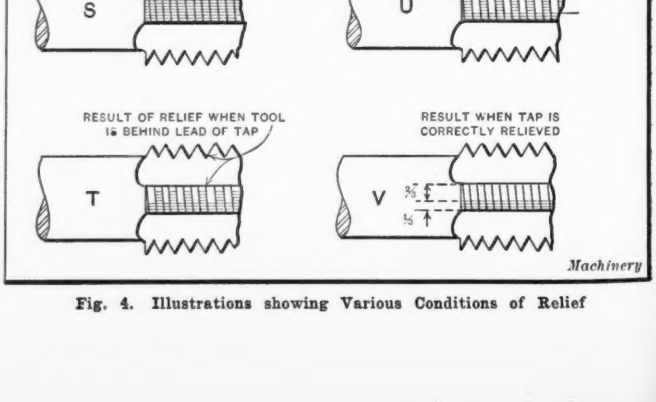


Fig. 4. Illustrations showing Various Conditions of Relief

* For additional information on the relief of taps, tap making and allied subjects published in MACHINERY, see also "Relief of Taps," January, 1914; "Relief of Taps," December, 1913; "Tap Fluting Cutters," March, 1913; "Special Shanks for Taps," February, 1913; "New Standard Dimensions for Taps," January, 1913; "Notes on the Early History of Tap Making," December, 1912; "Manufacture of Taps," January and February, 1909; "Testing the Lead of Taps and Screws," January, 1908; "Remarks on the Making of Hand Taps," June and July, 1907; "Formulas for Determining the Proportion of Taps," January, 1907; and "Proportions of Hand Taps in Sets," December, 1905.

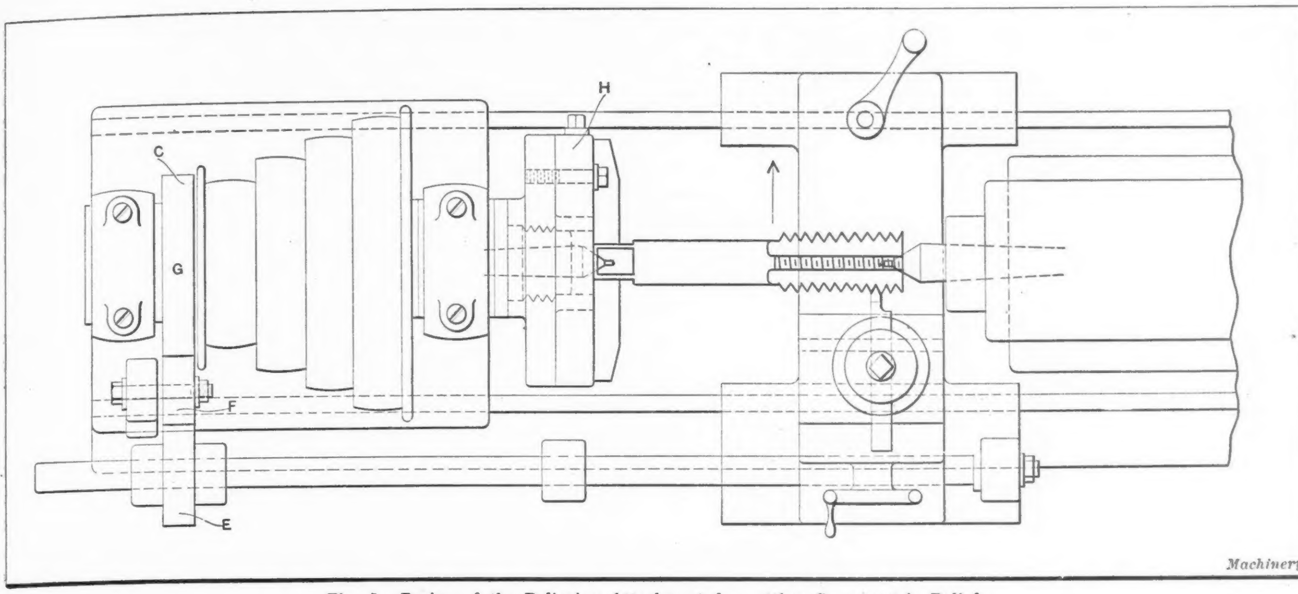


Fig. 5. Design of the Relieving Attachment for cutting Con-eccentric Relief

the cam and pulled back through the action of a counterweight. In some cases it is found advisable to substitute a spring in place of the counterweight. Power is transmitted to the driving shaft through the gears *E* and *F*, which, in turn, are driven from the gear *G* carried on the lathe spindle. The gear *E* is a change gear, different gears being substituted according to the number of lands on the tap. The relieving attachment is operated at a speed four times that of the lathe spindle in the case of taps with four lands to be machined, six times as fast if there are six lands, etc.

Before proceeding to machine the relief on the taps, they are taken to the hardening department and heated in a lead bath, after which they are allowed to cool gradually in the air. This leaves the surface a dark blue in color, as indicated by the shade lines in Fig. 4. When one of these colored taps is set up on the relieving lathe, the first thing to do is to have the reference mark on the square come under the screw of the two-jawed chuck *H* in Fig. 5. After screwing the tailstock center up to hold the work in place, tighten the chuck on the square end of the tap. This chuck is used in place of a driving dog in order to avoid lost motion which would cause the tap to "thump" when each land of the tap came in contact with the relieving tool. This would be disastrous to the tool and ruin the finish of the work. A detailed illustration of the special chuck used for holding the taps in the relieving lathe is shown in Fig. 6, where it will be seen that the jaws are operated by a single screw *J*. The jaws float in the slot *K* in order to eliminate any tendency to throw the tap off center, which might otherwise exist. It will be seen that the chuck is made in two parts *L* and *M* which are held together by two screws *N* which fit in elongated slots. The purpose of this construction will be explained in a subsequent paragraph.

With the tap set up on the lathe in the usual manner for threading, we proceed to pick up the thread. Particular care must be observed at this point, and the following outlines a little kink which facilitates the performance of this part of the work. A piece of white paper is placed on the cross-slide so that the space between the tap thread and the point of the threading tool can be clearly seen. In this way the operator knows just how far and in what direction the tool is out of lead with the tap. This will be better understood by referring to Fig. 7, where the amount that the tool is out of lead with the tap is shown by the space *O*, this space being clearly shown by the sheet of white paper *P* placed under the work. In order to get the tool into lead with the tap, the lever *Q* in Fig. 8 is thrown over to disengage the gears *R* that drive the screw-cutting attachment. The spindle is next turned and the gears re-engaged at another point which, in the operator's judgment, will give the correct lead. After allowing the lathe to turn through a few revolutions, the tool is once more tried with the thread to see if it engages properly with the lead of the tap, this procedure being repeated until the tap thread and tool match up as nearly as the eye can judge. A trial cut is then taken along the thread, and the manner in which the relief is being cut can be determined from the amount of colored surface that is removed. The result of this trial cut may produce either of the conditions illustrated in Fig. 4. In this illustration *S* shows the tap before starting to cut the relief, in which all of the color produced by treatment in the lead bath is still on the surface of the tap, this color being indicated by the shading. At *T* a tap is shown where the relief was cut with the travel of the tool behind the lead of the tap, this condition being indicated by one side of the thread having more of the coloring removed than the other. At *U* the tool is a little ahead of the lead of the tap, this being the reverse of the condition shown at *T*. Where the difference in lead is so slight that it can only be noticed by this method, it would not be possible to correct the error by throwing the gears out of mesh and re-engaging them at another point, as this is too coarse an adjustment. By tightening or loosening the tailstock center, however, the lead can be corrected very accurately, with the result that the tap is relieved correctly, as shown at *V* in Fig. 4. Referring to this illustration, it will be seen that the amount of coloring left on the surface of the tap and the amount removed are in the ratio of one-third to two-thirds, as they should be.

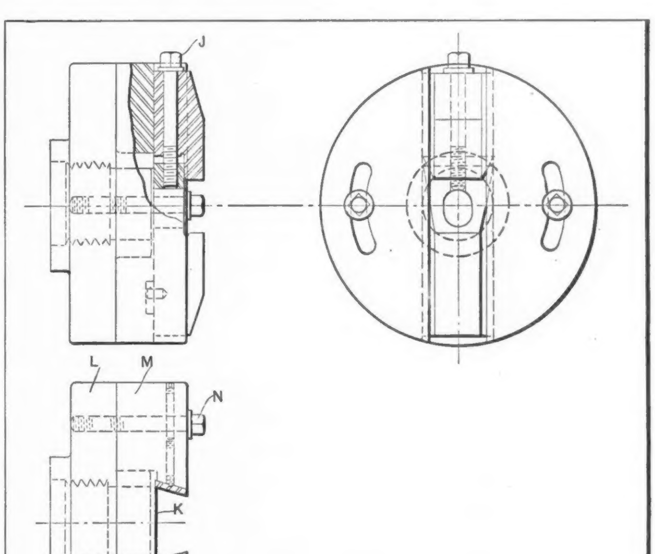
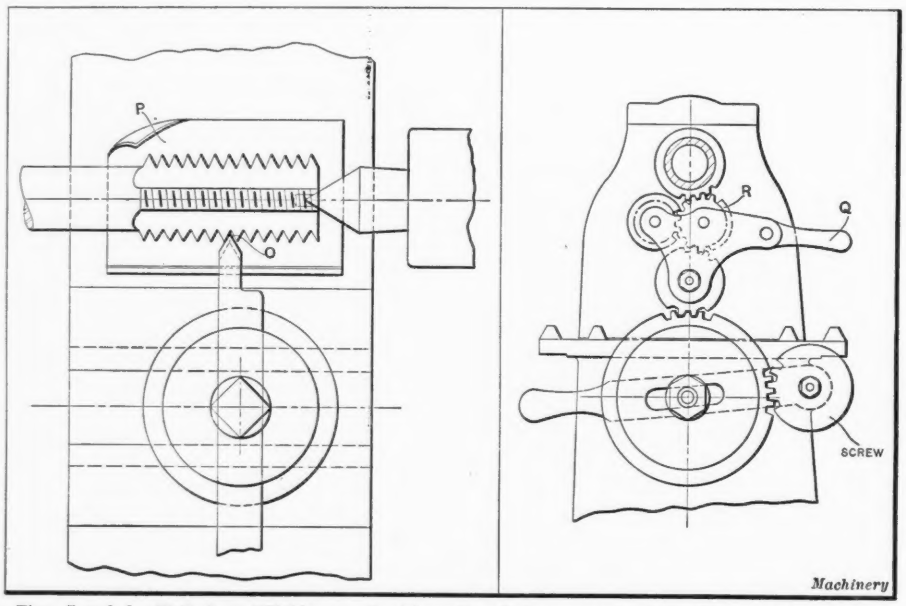


Fig. 6. Design of the Special Form of Chuck used

After the first tap of a given size has been set up and properly relieved, the remaining taps will come so near to being in lead with the tool that there is no need to bother with the method of throwing the gears out of mesh to obtain the proper position. Slight variations can be taken care of by manipulating the tailstock center as previously mentioned, and provided the prick-punch mark on the square was placed under the jaw with the screw in it, satisfactory results will be obtained. Should the lands or the helix of the thread vary greatly in their relation to the square with the prick-punch mark on it, this is evidence that the operator on one of the previous operations failed in properly locating the tap in the machine. This can sometimes be corrected by chucking on one of the other squares, if the error is in the fluting, or possibly the operator will have to disengage the gears in picking up the thread, in order to bring the tool into lead with the tap. It is necessary to start up the machine in order to take up any back-lash; then stop it and try the tool in the thread to see if everything is as it should be.

While this method holds good for V-threads, in machining taps with other types of threads, the tool will also be required to machine the top of the thread. Tools of this class for machining Acme and Whitworth threads are illustrated in Fig. 9. In connection with Fig. 6, it was mentioned that the chuck is made in two parts which are held together by screws fitting in elongated slots. The purpose of this construction is to enable the operator to move one part of the chuck independently of the spindle in order to bring the lands of the tap into correct relation with the cam of the relieving attachment. Although this may appear to be a somewhat complicated process, the operator will soon become proficient in following it. In fact, the method is much quicker than filing the relief, and as the equipment used is simple and does not interfere with the use of the lathe for other operations, there is a great advantage as compared with machines which can only be used for a single purpose. It must not be forgotten, however, that for making standard taps where it may be required to machine hundreds at a time, a special machine with cams of the required form, automatic feed for the cross-slide, and an automatic trip for operating the cross-slide —thus enabling the threading and relieving to be finished at the same time—will be far more economical. In using such machines, the flutes are milled last, so that care must be taken that they are milled in exactly the required place. This is provided for by using the reference mark placed on one of the squares on the tap shank.



Figs. 7 and 8. Method of "Picking up the Thread" and Arrangement of the Screw-cutting Gears

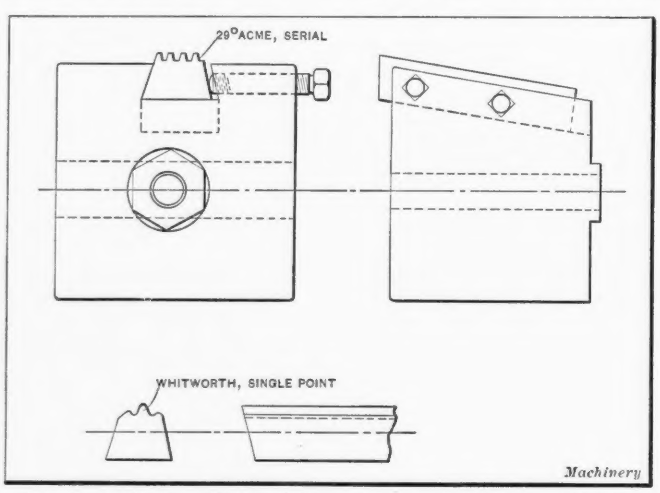


Fig. 9. Tools for relieving 29-degree Acme and Whitworth Threads

* * *

Remember there is always work for skilled hands.

STANDARDIZATION OF PIPE THREADS*

Pipe was first generally used in the latter part of the eighteenth century, when the invention of illuminating gas required some means to convey it from place to place. At about this time the long-continued war which had been in progress between France and England came to a close and a large quantity of gun barrel stock remained on the market. The first gas pipe was, therefore, made from gun barrels, and as these were made tapering, it was a simple matter to screw the small end of one into the large end of the next, thereby making a threaded socket joint. Thus, threads were used to connect pipe from the earliest time of its employment. There is no information as to what kinds of threads were used in the early days of gas pipe lines. The present standard for pipe threads in general use in the United States is named after Robert Briggs, who was active in gathering information regarding thread systems both in this country and in England. He had considerable engineering and manufacturing experience, and was for several years superintendent of the Pascal Iron Works, and later engineering editor of the *Journal of the Franklin Institute*. He did not originate the thread which bears his name, but standard gages for pipe threads were made under his supervision while he was with the Pascal Iron Works. These gages were used as master gages and were the standard employed by Messrs. Morris & Tasker, owners of the Pascal Iron Works, since they started the making of pipe about 1830. This firm was the first large manufacturer of pipe in the United States.

The cutting of taper threads on pipe or bolts was first accomplished in the lathe. The first record we have of a taper thread that could be cut by dies is in the invention of P. W. Gates, Jr., who, in 1847, patented a taper die. The adoption of taper dies soon became general, and the Crane Co., of Chicago, then known as the Northwestern Mfg. Co., as early as in 1866 listed taper taps and dies in sizes up to three inches.

However, few manufacturers adhered closely to the Briggs standard until 1885. At that time a committee was appointed by the American Society of Mechanical Engineers to confer with the manufacturers of pipe dies and fittings, with a view of bringing about and maintaining a uniformity in pipe threads by the use of gages which should definitely represent whatever standard was adopted. This committee issued circular letters to various manufacturers of pipe, boiler tubes and fittings, and in due time each manufacturer of pipe fittings or dies sent to the Pratt & Whitney Co., Hartford, Conn., a sample piece of pipe of each size, 6 inches and

* Abstract from an article by A. M. Houser and C. A. Olson of the Crane Co., Chicago, in the "Valve World."

smaller, threaded on one end according to their own standard. These samples were tested by the Pratt & Whitney Co. with Briggs standard gages, and a report was made to each manufacturer as to the state of his gages compared with the Briggs standard. In examining these samples certain variations from the Briggs standard were found to exist, but they were not great enough to warrant any departure from the Briggs gages, and it was, therefore, decided that the Briggs gages should be recognized as standard. This gave a standard for male threads for pipes or fittings, but no standard was adopted for female threads, and it has been the practice of manufacturers to tap female fittings so as to allow a certain number of turns of the male standard plug gage before binding. The number of threads "turn" adopted by various manufacturers varied somewhat. Because of this difference, therefore, a definite standard for ring pipe gages has now also been adopted. (Details of this standard were given in the May number of MACHINERY.)

* * *

BLANKING DIES FOR PUNCHING SAW-TOOTH SECTIONS

It is a recognized fact among diemakers that punchings with extremely sharp corners or points of a very acute angle are hard to produce, the difficulty being in the upkeep of the punch and die. The Nelson Tool Co. of New York City was recently called upon to make a punch and die for the piece of work illustrated in Fig. 2. This is a saw tooth section that is riveted on the edge of a cotton gin wheel. It was formerly the practice to make these cotton gin saws solid,

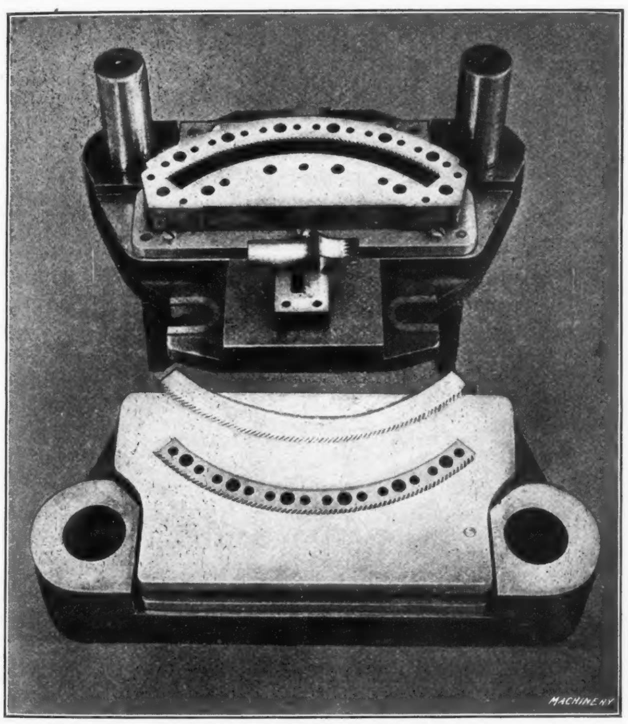


Fig. 1. Punch and Die and Trial Tools for making Blank in Fig. 2

indexing and cutting the teeth on a machine similar to a gear cutter. But as the teeth wore out rapidly it was found very expensive to keep replacing the saws, and so it was decided to make a punched segment that could be placed around the rim of a saw blank. The sheet steel, 0.017 inch thick, is a high carbon steel, capable of being hardened.

Before attempting to make the punch and die proper, a punch and die covering a small section was first made; this may be seen between the large punch and die in Fig. 1. The object of making this trial die was to punch enough of the steel to see how the points would stand up and thus determine whether it was practical to make the die or not. After 15,000 blanks had been run off on the small trial punch and die, and the corners of both punch and die had stood up in good shape, it was decided to make the die. Referring now to the punch and die shown in Fig. 1, the most difficult part is, of course, the making of the sections of the punch and die in which the teeth appear. It will be seen that these parts are composed of six sections, each of which is located by means of two dowel-pins and a screw. The sections may be followed by observing the groups of three holes, of which there are six on each of the curved tooth sections.

Observing carefully the shape of the teeth in Fig. 2, it will be seen that they are not straight but curved. This, of course, would render the shaping of the teeth by filing a very difficult job; therefore, the teeth in both punch and die were formed by milling. The teeth are spaced at a pitch

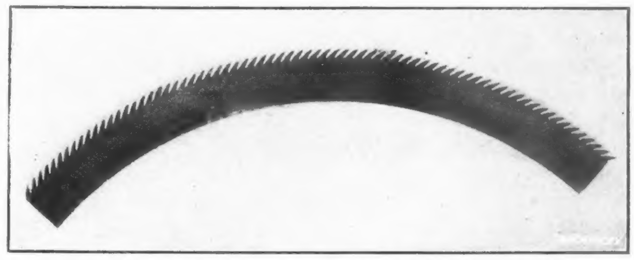


Fig. 2. Toothed Blank made in Punch and Die shown in Fig. 1

that would give 288 teeth in a complete revolution; therefore, the first thing to be done was to provide a means for indexing 1/288 of a revolution for each tooth. Fig. 3 shows how the blocks were mounted by dowel-pins on a master block, which, in turn, was clamped to the circular attachment of a Brown & Sharpe milling machine. The blocks were positioned with reference to a central arbor which may be seen in the foreground of this illustration, and the tooth section was therefore located at the proper radius from the arbor. Next, the collar on the rotating screw of the circular table was graduated with twenty-four divisions. As each revolution of the rotating screw turns the table one degree, it was necessary to move the rotating handle through thirty of the graduated lines or one and one-quarter revolution to get 1/288 part of the circumference.

A special cutter-base was made in which inserted teeth were placed, and while in place they were turned to the proper shape to cut the tooth shape in the punch or die section, as the case may be. Each of these sections was slightly relieved on the cutting edge for a distance of about ½ inch; this left the remaining ⅝ inch for the wearing life of the die. The sections were not mounted directly on the sub-press parts, but on separate plates that were removable to facilitate grinding. The main reason for making the die in sections was, of course, to obviate the shrinkage and distortion that might occur in hardening. Fitting the punch and die was particularly difficult because of the delicacy of the tooth outline. When the die was completed it fitted so well that thin paper was cut without leaving any burr. C. L. L.

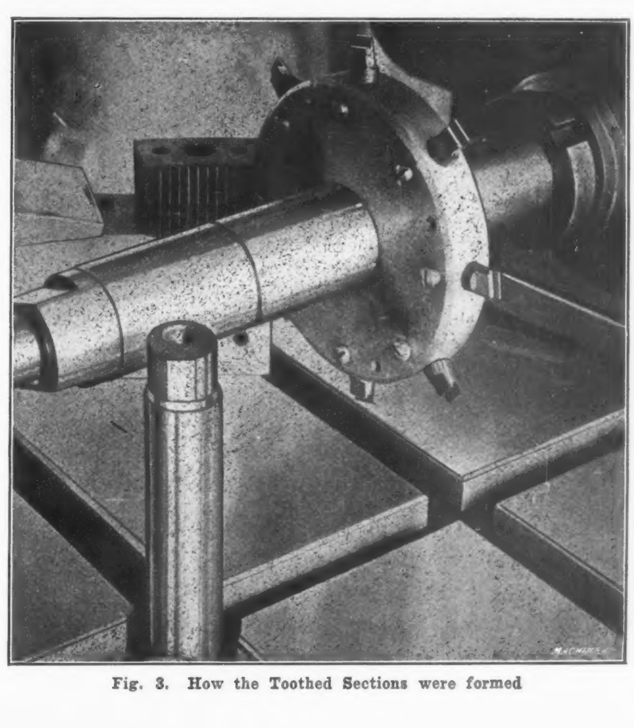


Fig. 3. How the Toothed Sections were formed

STATE LAWS ON ACCIDENT PREVENTION

SAFETY DEVICES AND CONDITIONS OF OPERATION REQUIRED BY LAW

BY MANCIUS S. HUTTON*

IT has only been within the last five years that a factory owner or company about to purchase a machine has taken the time and trouble to look at the danger points and see whether or not they are properly safeguarded before deciding upon what make to buy. This change of attitude upon the part of the purchaser has been brought about through the passage of the workmen's compensation laws and the state factory investigations, resulting in the passage of more exacting laws in regard to the requirements of safety devices that must be provided in factories, work shops and mercantile establishments in the different states. If the manufacturer should not furnish an adequate guard which will meet the requirements of either the state or insurance company's inspectors, he may be asked to make the necessary changes in his shop before shipping, or the purchaser may have to provide the guards after receiving the machine. In either case there will be a delay before the machine can become productive. The cost in placing the guards on the machine after it has been assembled will in all probability be more than if they were put on while being built. At the present time, a machine will be given greater preference from the purchaser if it can be shown that it amply protects the workman against injury and will meet every requirement of the state labor-law enforcing body and the insurance companies.

The American Bridge Co. has the following words stamped on every letter sent out by their purchasing agent in pursuit of material or machines: "Provisions for safeguarding workmen should be brought to our attention, as we will consider them in selecting new machinery and equipment." Another company having its factory in New York State has the following note made a part of each order and contract: "This order for machinery is accepted with the understanding that it will in all requirements absolutely comply in every particular with the New York state laws as laid down for the preservation of life and limb, and of machine operators, or any persons whose duties may call them around the machine, as such laws may be interpreted by the New York state inspector. Unless the machine is received in this condition, we reserve the right to return it at once without notification, charging the transportation charges to the maker, or to make such changes as may be necessary to make it satisfactory to the New York state inspector, and take the same from the price formerly agreed upon." Other companies have given notice to the manufacturers that safety is one of the most important things that will be considered when purchasing new machines.

One of the crying needs of today is uniformity of practice in the matter of safeguards, *i. e.*, what is to be guarded and how. On account of the varying conditions to be met in the different shops throughout the country, those who are in the factory inspection departments say that it is impossible to draw up a definite set of rules which can be applied to all conditions. Some of the large companies and railroads which have a large number of plants situated in the different states have, however, decided upon a certain standard of safety which is used in all their factories.

Out of the forty-eight states in the union the following eighteen have no laws concerning safeguarding machinery: Alabama, Arizona, North and South Carolina, North and South Dakota, Delaware, Florida, Georgia, Idaho, Kentucky, Mississippi, Montana, Nevada, New Mexico, Texas, Utah and Wyoming. In Louisiana, Maine and Maryland there are only laws regarding sanitation in factories. Again in Arkansas, Missouri, and New Hampshire the laws are not of the kind that either the manufacturer or the purchaser is interested in. This leaves the following twenty-four states which have laws of interest to the readers of this journal: California, Colorado, Connecticut, Illinois, Indiana, Iowa, Kansas, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Vermont, Virginia, West Virginia, Washington and Wisconsin. Undoubtedly before very long the twenty-four states which have been backward in protecting their industrial workers will step to the front and become the leaders in the safety movement.

A glance at this list of twenty-four states reveals the fact that practically all of them are either agricultural or mining states and that with the exception of four these states do not have more than 100,000 industrial workers. In nearly all of the large mining states such as Arizona, Pennsylvania and West Virginia there are laws for the protection of miners which are not included in this article. These laws are enforced by a different set of inspectors who are usually expert miners.

When the states labor laws were first framed the question of whether a guard was to be placed over a certain machine or a part of a machine was left entirely to the judgment of the commissioner of labor or his assistants. The wordings of the laws have changed in this respect in a number of states latterly by making it mandatory upon the owner or person in charge of a factory to provide safeguards upon the machines or machinery mentioned in the laws. Machines may sometimes be so placed in the shop that no known guard could be used, in which case the law says that a guard must be used "if practicable." A list of the states which still leave to the discretion of the inspectors the question of safeguarding a machine or machinery are the following: Indiana, Michigan, Rhode Island, Tennessee and Vermont.

In an examination of these laws it will be found that a large number of them were written before the advent of the safety movement and have not been changed since that time. They merely mention the names of some of the machines and machinery or part of it that must be guarded, giving very little information as to how or how much of it must be guarded, this being left to the owner and inspector to decide.

The laws in the twenty-four states which are of interest to both the manufacturer and the purchaser can be divided into three groups which, again, can be subdivided. The groups are: 1. transmission machinery; 2. productive machines; and 3. hygiene and sanitation.

TRANSMISSION MACHINERY

Mechanical

1. *Belt Shifters.*—"Belt shifters or other mechanical contrivance for the purpose of throwing on or off belts or pulleys while running." This expression is found at present in the laws of the following fifteen states: Colorado, Indiana, Iowa, Kansas, Michigan, Minnesota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Washington, and Virginia. In Wisconsin the industrial commission has made the following rulings: All loose pulleys must be furnished with a permanent belt shifter, so located as to be within easy reach of the operator. All belt shifters must be so constructed as to make it impossible for the belt to creep and must be equipped with a lock or some other efficient device which will prevent the shifter from being accidentally shifted. Illinois also mentions the fact that the belt shifter must be placed within easy reach of the operator.

2. *Loose Pulleys.*—"Wherever practical all machinery shall be provided with loose pulleys." In Illinois it is only on machines which are required to be started and stopped frequently that loose pulleys must be used. In place of the loose pulley a clutch or other disengaging device can be provided. In Wisconsin the loose pulley or clutch is required on all machines that are not individually motor driven. The number of states requiring loose pulleys is eleven. They are the same as those that require belt shifters, with the exception of Colorado, Iowa, Nebraska, Ohio, Oklahoma, Oregon and Washington.

Drums.—"Drums,—etc., shall be guarded." The word drum appears in the text of the laws of nine states, namely:

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* Address: 257 W. 86th St., New York City.

Connecticut, Illinois, Massachusetts, Minnesota, New Jersey, Rhode Island, Tennessee, Vermont and West Virginia.

3. *Belting, Shafting and Gearing.*—"All cogs, gearing, belting, shafting and machinery of every description shall be properly guarded." This is practically the wording in the text of the laws of twenty-one states with the exception of New York and Wisconsin which are given below. The names of these states are the same as those given under belt shifters with the addition of Connecticut, Massachusetts, Rhode Island, Tennessee and Vermont. According to the New York law all belting and revolving shafting within seven feet of the floors must be protected on its exposed surface by being encased so as to effectively prevent any part of the body, hair or clothing of all persons from coming in contact with such belting or shafting. The wording of the rules in Wisconsin are as follows: "All belts, ropes or chain driving machinery or shafting exposed to contact, except those which are so small or those which move so slowly that there is no possibility of danger, must be guarded. In all cases the point where the belt, rope or chain runs onto the pulley, sheave or sprocket must be guarded. All horizontal belts, ropes or chains driving machinery or shafting seven feet or less from the floor, where exposed to contact, must be guarded. Note:—In guarding overhead belts or rope drives, unless so guarded that persons cannot pass under them, the width of the guard should not be less than the width of the belt or rope drive and the length should not be less than the distance between the outer faces of the two pulleys. It should cover the outer faces of the two pulleys or sheaves and extend upward to such a point and be attached in such a way that in case the belt breaks it will withstand the whipping force of the belt." "All gears where exposed to contact must be entirely enclosed or equipped with a flange guard which must enclose the teeth of the gears. All arm or spoke gears and all web gears with holes in the web, which are over eighteen inches in diameter, where exposed to contact, must be entirely enclosed." "All transmission shafting in work-rooms or in passageways leading to work-rooms and located less than six and one-half feet from the floor, where exposed to contact, must be guarded." Besides Wisconsin, Minnesota mentions rope and chain drives as requiring to be protected in the state.

4. *Pulleys, Clutches, Friction Drives and Sprockets.*—These are only mentioned in Wisconsin, where the rules say that pulleys near the shaft hanger must be provided with a guard placed adjacent to the pulley to prevent the belt from leaving the pulley and also that all pulleys over eighteen inches in diameter, which are exposed to contact, must be guarded. Again, all clutches and sprockets must be guarded especially when exposed to contact. The contact faces of all arm or spoke friction drives and all web friction drives with holes in the web, when over eighteen inches in diameter and exposed to contact must be entirely enclosed.

5. *Flywheels.*—"All vats, pans, saws, gearing, shafting, flywheels, etc., and machinery of every description shall be guarded." This is the wording in the states of Illinois, Minnesota, Ohio and Pennsylvania. In Wisconsin the rules state that all sections of flywheels, with spokes, which are six feet or less from the floor and which are exposed to contact must be guarded. Flywheels which run in pits must be provided with toe boards around the pit. The guard around the flywheel of an engine located in the engine room may be in the form of a railing. This railing must not be less than thirty inches in height and must be constructed of two rails, the bottom one being not less than eighteen inches from the floor.

6. *Conveyors.*—These are merely mentioned as requiring to be safeguarded in the states of Colorado and Washington.

7. *Mechanical Stop for Machines.*—A loose pulley, clutch or other adequate device must be placed within easy reach of the machine operator in the states of Nebraska and Wisconsin so that any machine can be stopped instantly. In New Jersey the law calls for friction clutches to be provided in order to stop machinery. In Illinois where the machines are direct-connected to the prime mover, where arranged in groups and power supplied by the prime mover located in the confines of such group, or where arranged in groups with prime mover located without the group, the power being received through a main shaft or lineshaft; a switch, throttle or other power controlling device shall be furnished and placed within easy reach of the operators affected, so that all shafting, transmission machinery and machines of such group can be simultaneously shut down in case of need or accident.

Electrical

The guarding of the electrical transmission wires in a factory or work-shop is mentioned in the laws of Illinois and Minnesota.

PRODUCTIVE MACHINES OR MACHINERY

Before taking up the individual machines as a whole it will be advisable to refer to certain parts which need to be protected.

1. *Set-screws, Keys and Bolts.*—These are mentioned as in need of protection in seventeen states, of which fourteen casually mention them in the same class as belting. These states are the same as those given under belt shifters with the exception of Minnesota, Oregon and West Virginia. In New York and Ohio the law states that all set-screws, keys, bolts and all parts projecting beyond the surface of the revolving shaft shall be countersunk or provided with a suitable covering. In Wisconsin the meaning is the same as regards set-screws as in the New York law but the wording is different. As regards keys and keyseats, the latter state says that all projecting keys or keyseats, where exposed to contact, must be guarded. An exception is made with keyseats on machines which are impossible to guard or fill without interfering with the operation, or where they are in shafts that are so small or run so slowly that there is no danger.

2. *The Shuttle of a Loom.*—In Illinois and Massachusetts a guard must be placed to prevent the shuttle from flying out at each end of its travel. Massachusetts also forbids the use of a shuttle which requires the operator to use his mouth or lip to thread it. This is a hygienic precaution rather than a safety regulation.

3. *Counterweights and Balance Gears.*—The covering or fencing in of these is required in Minnesota.

4. *Line Rollers.*—The need of some kind of protection for the employes working around line rollers is mentioned in the laws of Colorado, Illinois, Nebraska, Oregon and Washington.

5. *Ovens, Furnaces, Forges and Tables.*—Why Illinois should mention these as especially requiring a guard is not very clear, but such is the case.

6. *Woodworking Machinery.* In Illinois saws, planers, shapers and sandpapering machines, in Ohio saws, planers and shapers, while in Wisconsin saws, planers, shapers and stickers must be guarded. The other states which require saw and planer guards are Colorado, Indiana, Iowa, Kansas, Michigan, Nebraska, New Jersey, New York, Oklahoma, Oregon, Pennsylvania, Vermont, Virginia, and Washington. Trimmers are required to be guarded in Colorado and Washington. In practically all the states, with the exception of Wisconsin, these machines are mentioned in the same sentence as belting, gearing, vats and pans. In Wisconsin the rules of the industrial commission are that all hand jointers or planers must be equipped with a safety cylinder head and have a guard placed over the knives. Also that all band saws, both the upper and lower wheels and the saw itself, except that part below the saw guide, must be covered. Circular saws, besides being guarded, must be provided with a splitter. In general, all knife heads, wood shapers, stickers, planers, when exposed to contact, must be guarded. West Virginia alludes to a corner machine as one on which a safety device must be placed.

7. *Laundry Machinery.*—All laundry machines in Illinois are considered dangerous and therefore will be required to be safeguarded. Besides Illinois, mangles are required to be protected in Colorado and Washington.

8. *Hydro-extractors.*—A screen must be placed over hydro-extractors in Illinois, Nebraska and New York.

9. *Power and Foot Presses.*—This class of machines causes, next to the saws and planers, the greatest number of accidents, yet it is only given in the law of one state—New Jersey.

10. *Paper Machines.*—An inspector knows from experience that certain machines to be found in paper mills should be fully protected, yet it is a fact that Illinois is the only state to mention this class of machines.

11. *Corn Shredders.*—Corn shredders or husking machines are not allowed to be sold or offered for sale in Minnesota and Wisconsin unless provided with reasonable safety devices to protect the operator from accidents from the snapping and husking rollers, and these guards must be so designed as to compel the operator to stand a safe distance from the rollers while feeding the machine.

12. *Electrical Apparatus and Appliances.*—All dynamos, motors, switches, fuses, etc., must be guarded in Illinois and Minnesota.

13. *"Machinery of Every Description."*—This phrase is to be found in sixteen of the state laws. It simply means that dangerous machines or machinery which are not definitely stated in the law can be required to be guarded if the inspector considers it desirable to do so in order to prevent accidents. In certain states such as Minnesota, the following sentence is to be found: "All dangerous parts of machinery ———— shall be fenced, boxed or otherwise protected." While the wording is different, the meaning is exactly the same as the above.

HYGIENE AND SANITATION

Dust-Creating Machinery

1. *Grinding and Buffing Machines.*—"Exhaust fans of sufficient power shall be provided for the purpose of carrying off dust from emery wheels and grindstones and dust-creating machinery from establishments where used." This is the wording in the states of Indiana and Minnesota. The meaning of the law in Iowa is the same as that expressed above with the addition that the exhaust system must be carried outside the building or to some receptacle placed so as to receive the dust. In Connecticut an exhaust system must be installed in any process which generates an excessive amount of dust. In this state tripoli, rouge and corundum wheels are mentioned besides emery. The Colorado and Washington law is very similar to that of Connecticut. In Wisconsin the dust-creating machinery must be equipped with either an exhaust or water system which will remove all particles of dust that are light enough to float in the air. In New York the exhaust fan which operates the exhaust system must be of sufficient capacity and power and must be kept running constantly while the machines are in use. In Massachusetts, Michigan, New Jersey, Ohio and Pennsylvania emery belts of either leather, leather covered, felt, canvas, paper, cotton, or wheels or belts rolled or coated with emery or corundum, or cotton wheels used as buffs besides the solid emery wheels, shall be provided with an exhaust or blowers placed over, beside or under the wheels or belts, arranged in such a manner as to carry off the dust arising from or thrown off the same while in operation. Massachusetts also has a law requiring an exhaust system on this class of machines. The laws of Connecticut, Indiana, Iowa, New York, Minnesota, Washington and Wisconsin require exhaust systems or other efficient dust-removing means on all dust-creating machinery. There are a number of cases in which grinding wheels are exempt from these requirements in certain of the states. These exemptions are as follows:

a. Grinding machinery upon which water is used at the point of grinding contact.

b. Small emery wheels which are used temporarily for tool grinding.

c. Solid emery wheels used in woodworking establishments.

d. Wheels or belts which are not used continuously more than three hours in the twenty-four.

e. Small shops employing not more than one man at work upon an emery wheel.

f. Emery wheels which are in general use by all employes, in common, for touching up tools or castings or for sharpening saws.

g. Emery wheels six inches or less in diameter used in establishments where the principal business is not emery wheel grinding. The exemption under *a* is found in the states of Iowa, Massachusetts, New Jersey, New York, Ohio and Pennsylvania; *b* in Iowa, Massachusetts, New Jersey; *c* in New York; *d* in Pennsylvania; *e* in Ohio; *f* in Wisconsin; and *g* in Massachusetts. In the laws of Michigan, New Jersey, Ohio and Washington, the material of which the hood or hopper of the wheel is made, the size of the exhaust pipe and the capacity and power of the exhaust fan are laid down definitely; while in New York the same data has been collected and published by the State Department of Labor in book form. In Massachusetts, New York and New Jersey the plans of an exhaust installation must be submitted to the proper state department for approval before commencing work.

2. *Tumbling Barrels or Rattlers.*—These are mentioned specifically in Iowa and Wisconsin.

3. *Flint Grinding.*—The flint grinding mills of Maryland are required to be equipped with an exhaust system to carry the flint dust away from the place where the men have to work.

4. *Hair Picking Machines.*—In the upholstering or mattress establishments or other factories in Michigan where hair, moss, tow or cotton is used for filling, the hair picking machines shall be placed in such a position as to carry away the dust thrown off by the machines while in operation directly to the outside of the building or to some other receptacle established to receive and confine the dust.

5. *Industries or Processes in which Lead is used.*—In order to prevent lead poisoning the laws of Ohio and Pennsylvania require that the crushing, mixing, shifting, grinding and packing of all the lead salts or other compounds shall be so conducted as to keep the air in the work-room in which the process is carried on free from the dry lead dust. This is done by requiring all hoppers, chutes, conveyors, elevators, vents from separators, dumps, pulverizers, chasers, dry pans or other apparatus for drying pulp lead, dry pan dumps and all barrel packers and cars or other receptacles into which corrosives are emptied to be connected with a dust collecting system. Also all vessels or containers in which dry lead in any chemical form is being conveyed from one place to another within the factory shall be equipped at the places where the same are filled or discharged with hoods having connection with an air-exhaust. Such exhaust system should be regulated by the discharge of air from a fan, either through a cloth dust-collector having an area of not less than one-half square foot of cloth to every cubic foot of air passing through it per minute, the dust collector to be placed in a separate room which no employe shall be required or allowed to enter except for essential repairs while the works are in operation, or by any other apparatus which will efficiently remove the lead dust from the air before it is discharged into the outer air.

Machines and Processes Giving Off Fumes

1. *Vats and Pans.*—"Shall provide and maintain in use reasonable safeguards for all vats, pans, etc." This is practically the wording in Colorado, Indiana, Kansas, Michigan, Minnesota, New Jersey, Oklahoma, Pennsylvania, Vermont, Virginia, Washington and Wisconsin. The words "giving off fumes or vapors which are irritating, obnoxious or injurious to the health" are added in the Wisconsin rules, while the words "containing molten metal or hot or corrosive fluids" have been added to the Colorado law in Illinois, Maine, Rhode Island and Tennessee. In New York every vat or pan which is so located that the top is on a lower level than the operator's elbow shall be protected with a cover which shall be maintained over the same while in use in such a manner as to prevent the operator or other persons falling in or coming in contact with their contents. Should it be necessary to remove the cover from the vat or pan while it is in use it shall be protected by a railing placed around the same.

2. *Linotype and Type Casting Machines.*—In Louisiana every newspaper or printing concern using three or more linotypes or other type casting machines is required to install an exhaust fan or other device sufficient to keep pure air circulating and to expel the fumes. They must also install a vent pipe on each machine running from the metal pot to a flue or other aperture. Iowa has the same provision.

3. *Industries or Processes in which Lead is used.* The two states that require exhaust systems to carry off the lead dust also require that the lead fumes be carried out of the room in which the employes work.

General Ventilation and Sanitation

In several of the states such as Connecticut, Colorado, Massachusetts, Maine, Oregon, Rhode Island, Tennessee and Vermont the state inspector can order changes to be made in a factory should he consider either the heating, lighting, ventilation or sanitary conditions to be injurious to the health of the workmen. Under this general clause a commissioner of labor or his inspectors in these states can order an employer to install a vacuum system on all dust-creating machinery and a vent for receptacles containing molten metal or hot liquids which give off obnoxious fumes.

In what has preceded no mention has been made concerning what was required in the way of safeguarding the employes in the state of California. The reason for this is that on the first of this year the inspection of factories and the issuing of rules in regard to protection became a part of the duties of the industrial accident commission which was created in 1911 to handle the operation of the workmen's compensation law. The commission has not, as yet, made rules for the guidance of the employers of the state and its own inspectors. There is no doubt but that this state will place itself in the very forefront of the safety movement. The commission is given very liberal powers and the new law expressly states in Section 52 that "every employer shall furnish employment which shall be safe for the employes therein and shall furnish a place of employment which shall be safe for employes therein and shall furnish and use such safety devices and safeguards and shall adopt and use such practices, means, methods, to render such employment and place of employment safe and shall do every other thing reasonably necessary to protect the life and safety of such employes."

According to the secretary of state of North Carolina there is a common law in that state which requires that employers shall furnish reasonably safe appliances for their employes. But it can be seen that this law would become a dead letter in this state, as the commissioner and his deputy are not required to examine industrial plants except those against which a complaint has been lodged. The only qualifications that the commissioner has to have is that he be a practical printer.

Section 5 of the safety law of the state of Minnesota requires that "whenever practicable the point of danger in any machine or mechanism shall be securely guarded by the maker and the manufacture or sale of any machine or mechanism not so guarded is hereby prohibited." At the present time this is the only state which is prohibiting the manufacture and sale of unguarded machinery.

The industrial commission of Wisconsin has determined upon the following standards regarding safeguards:

1. No safeguard required which cannot be proved to be practical.
2. No safeguard required which the commission cannot show how to install.
3. Homemade safeguards which as far as possible can be constructed and installed cheaply in the shop.

As a part of the safety laws in Colorado, Indiana, Minnesota, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Virginia, West Virginia and Wisconsin, it is stipulated that should a machine or any part of it be found in a dangerous condition or not properly guarded the commissioner of labor or one of his inspectors may prohibit the use of the machine until the same has been made safe. He is required to attach a notice to the machine while it is in the unsafe condition calling attention to the same.

In Illinois, Indiana, Minnesota, New Jersey, New York, Pennsylvania and Virginia no person is allowed to remove or make ineffective any safeguard while working at the guarded machine except for making immediate repair, and after being repaired it should be promptly replaced.

The interpretating and enforcing of the labor laws is done through a state department or commission consisting of a chief inspector and a number of assistants. The inspectors have the right of entry into a factory of the state during regular working hours as often as they may consider it necessary for the purpose of inspection. The salary paid the state factory inspector in most of the states is never higher than $2000 and in most cases is in the neighborhood of $1200 to $1500 a year. The chief inspector or commissioner of labor receives a salary varying from $1800 to $8000.

In twenty-eight states the inspectors are not required to pass a civil service examination nor is any practical experience or technical training required of them, while in five states that have no civil service requirement the inspectors are required to have some practical experience. In nine states the inspectors must pass a civil service examination before being appointed.

In three states—California, Ohio and Wisconsin—the state factory inspection department has been absorbed by the industrial commission which now has charge of the inspection of factories as well as the administration of the workmen's compensation law.

In New York and Pennsylvania there has been created an industrial board consisting of the commissioner of labor and four associates. In Massachusetts the state board of labor and industries and the industrial accident board, sitting jointly, act in the same capacity as an industrial board. They have the power to obtain the services of experts upon their committees. These persons serve without pay. The board in each of these states has the power to draw up rules and regulations regarding the installation, position, operation and use of machines and machinery, the furnishing and use of safety devices and appliances for machines and of guards to be worn upon the person and other cognate matters, whenever it finds such regulations necessary in order to provide for the prevention of accidents in factories. These rules and regulations after a public hearing become the same as law. All meetings of the board are open to the public. The industrial commissions spoken of above have also the same power as regards the making of rules which eventually become laws. Besides the making of laws, they have the right to make exceptions to existing laws where they see that the letting down of the bars will not increase the number of accidents.

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INCREASING THE EFFICIENCY OF THE CUTTING TORCH

Experiments recently conducted in cutting with oxy-hydrogen and oxy-acetylene cutting torches show that a marked increase in the rate of production is effected by increasing the temperature of the oxygen. The most favorable results secured in this connection show that the increase of speed obtained by preheating the oxgyen is 18 per cent, while the saving in the amount of oxygen used was 55 per cent. As an increase in temperature means a corresponding increase in the pressure of the oxygen, it seemed possible that merely increasing the pressure would have the same effect. Experiments along this line proved that this reasoning was correct. Where the pressure was steadily increased, it was found that the rate of cutting increased in direct proportion. It was found, however, that the higher pressures had a tendency to round the upper edge of the cut. A pressure of 35.5 pounds per square inch seems to be about the maximum amount with which perfect work could be produced. With very low pressures, the rate of cutting was not only very slow, but the cut itself was defective. Experiments were also tried in changing the ratio of hydrogen to oxygen, and it was found that where this ratio was 15 to 4 instead of the customary 4 to 1, the rate of cutting was exceptionally high in cases where the pressure of the oxygen was about the maximum of 35.5 pounds per square inch.

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Careful measurements were made during the past year by means of which it was determined that the soot fall in Pittsburg ranges from 595 to 1950 tons per square mile per year. London has been considered one of the "gloomiest" cities in the world, yet the soot fall in London is only 426 tons per square mile per year.

CRANKSHAFT GRINDING*

PRACTICE OF THE REO MOTOR CAR CO.

BY ROSS HOLMES†

THERE is in existence a great deal of valuable data relative to feeds, speeds and depths of cut for the best modern lathe practice. Knowing the depth of cut, it is possible to determine the best relation of speed and feed, by reference to this data which has been collected in the form of charts and tables. In attempting to do the same thing in connection with grinding methods, I was unable to find any information on the subject. Work of that kind had been arranged by cut-and-try methods, the production being recorded and the maximum speeds obtained in that way. To obtain such data, the crankshaft used in the "Reo the Fifth" motor was chosen for observation and time study. It is drop-forged from manganese steel and heat-treated. The crankpins are ground from the rough, while the bearings and pilot ends are rough-turned on a lathe. The rough forgings are first sawed to length and centered, and then the center bearing is ground for a space somewhat narrower than the bearing. This is to provide a bearing for the steadyrest on the lathe. The end bearings are now rough-turned and the pins are next rough- and finish-ground. Then the bearings are finish-ground, and also the end pilots, the tapering portion on which the flywheel is forced, and the "gear fit" which is so called since it receives the timer gear. The next operation is on a lathe, which cuts the gear fit off to the exact length and cuts the threads on it with a Geometric die. Holes are drilled in the centers of the crankpins to roughly balance the crankshaft and an emery wheel grinds the shaft to a perfect running balance. A flat spot and a keyway are next milled out, and a keyway is cut for the flywheel key. A drill press completes the series of operations by drilling the oil and pin holes.

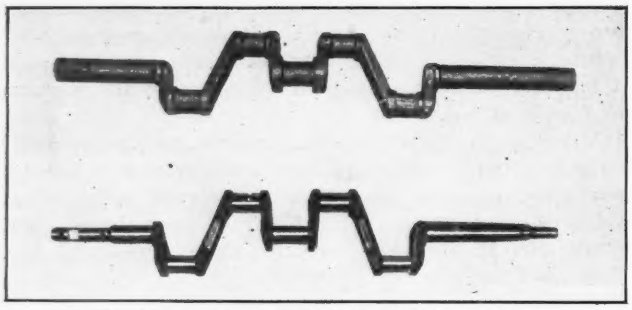


Fig. 1. One of the Finished Crankshafts and the Rough Drop-forging

In this investigation the roughing speeds on the pins and the first grinding operation on the center bearing were found to be within 2 per cent of each other, while the material handling and adjustment times varied less than 5 per cent. The first of the grinding operations—spot-centering the bearing—is done on a 14 by 50-inch Norton grinder with a Norton 24-N flanged wheel. This wheel is dressed by a diamond, using the hand motion and not the traverse. Such a dressing is required for every four shafts, and gives a good roughing wheel surface which is square but not too smooth. A driver similar to the one illustrated is a time-saving substitute for the grinder dog. The feed is by hand, the wheel being advanced every revolution as nearly 0.02 inch as possible.

The cutting time averaged 1 minute 48.75 seconds and the changing time 27 seconds. The time required for dressing the wheel was 66 seconds, which, distributed over the four crankshafts, gives an average of 16½ seconds. This gives a total of 2 minutes 32.25 seconds each as the fastest continuous speed that it is possible to maintain. It is possible to hurry the work for short intervals and reduce the cutting time from 108.75 seconds to about 90 seconds, but this soon leads to the belts crowding off and when this occurs it involves about 100 seconds to readjust the machine and have the wheel gather up the requisite speed, which more than counterbalances the reduced cutting time. At the time of this observation, the wheel was 19⅝ inches in diameter, which at 1170 R. P. M. gives a surface velocity of 6020 feet per minute. The bearing is 1.73 inch in diameter and must be ground down to 1.52 inch. With the work turning at 27 R. P. M., a surface velocity of 12.3 feet per minute is obtained. The approximate volume of metal removed is 0.105 (depth of cut) by 2.75 (width) by 1.625 inch (mean diameter) which gives a volume of 1.48 cubic inch or 0.415 pound.

Following this spot-centering operation, the shaft goes to the shouldering lathe, shown in Fig. 3, which is an engine lathe fitted with a turret on the tool-slide and also two additional tool-slides. The center tool machines the center bearing to the correct width, while the other two tools are run in just outside of the crank throws to leave the rough fillet on the end bearings ready for the grinder. The turret tools are split, thus being accurately adjusted for width. The end or line bearings are rough-turned on the lathe shown in Fig. 4. This lathe uses a side-cutting tool with a broad blunt nose instead of the customary round-nosed tool. This avoids any tendency to "draw in," and at the same time it can take a cut the full length of the tool, making it possible to rough-size the bearing in one cut instead of needing two or three to reduce it to the correct size. This tool, shown in the foreground of the illustration, is ground flat on top, with a groove parallel to one side made with the corner of the wheel, allowing clearance for the steel shaving. The cut of this tool is square with the work, and it is for this reason that the two narrow, round-nosed tools are used in the previous operation to round the fillets and mark the end of the cut.

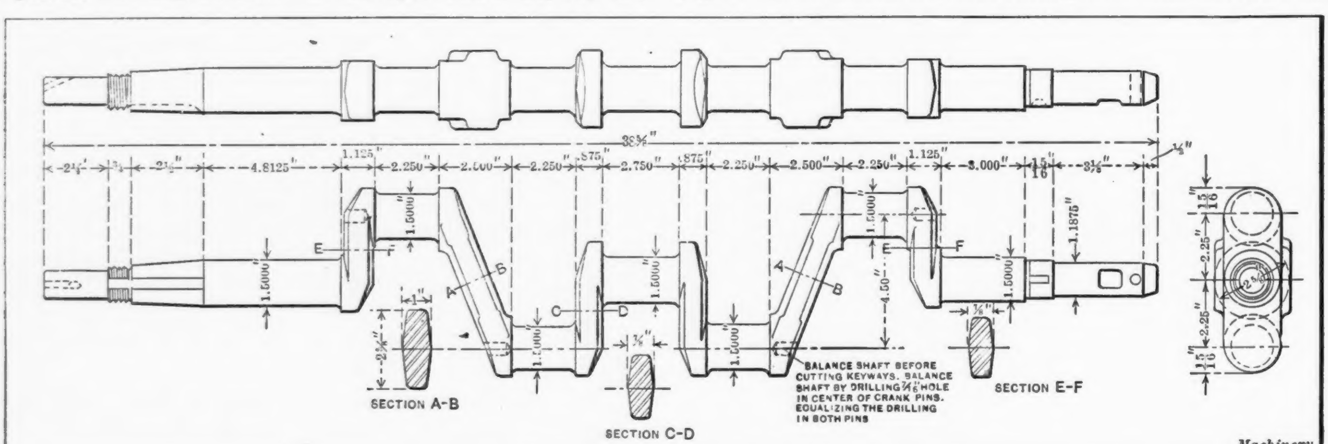


Fig. 2. Important Dimensions of the Crankshaft shown in Fig. 1

* For additional information on grinding crankshafts and allied subjects published in MACHINERY see also "Efficient Production of Cylindrical Work," December, 1912; "Rough Turning vs. Rough Grinding of Crankshaft Pins," March, 1911; "The Field for Grinding," January, 1911; "Precision Grinding," January, 1911; "Grinding Economy," July, 1910; "Economy in Grinding," May, 1910; "The Manufacture of Crankshafts," July, 1909; "Grinding a Large Crankshaft," April, 1907; "Grinding Crankshafts," March, 1907; and "The Cost of Grinding," October, 1906.

† Care of Reo Motor Car Co., Lansing, Mich.

The other rough-grinding operation, namely on the crank-pins, is done with a 24-inch Grade O wheel which requires dressing for every third crankshaft. This wheel was 23½ inches in diameter at the time of the test, the exact width of pin 2¼ inches and the speed 955 R. P. M., which gives a surface speed of 5890 feet per minute. The standard Norton offset for crankshafts which was used was removed and set up by a helper. In setting up, use is made of a metal-balancing plate which has tapering wedges that force the pins equidistant from a surface plate; and this locates the crankshaft centrally in the offset, so that the same amount of stock is removed from all the pins. In placing this work in the grinder, a gage is put on the shaft and the work shifted until the wheel touches the gage. It is now in position for grinding the first pin. A standard spacing bar is set from this position and the other pins are thus accurately spaced. On the first revolution of the work 0.02 inch is cut from the forged fillet before the work gathers up motion. The hand feed is about 0.02 inch per revolution of the work. In operating the machine, two pins on a line are first ground; and then the offset is shifted to the other center and the other two pins are ground. The time required is as follows:

Grinding time per pin.........	1 minute 26.375 seconds
Change centers	29 seconds
Change work	1 minute 23.50 seconds
Dress wheel	2 minutes 2 seconds
Dress wheel, per shaft.........	40.66 seconds
Total time for grinding four pins, changing and dressing wheel	8 minutes 18.6 seconds

The volume of stock removed is approximately 1.625 inch (mean diameter) by 2¼ inches (width) by 0.105 inch (depth

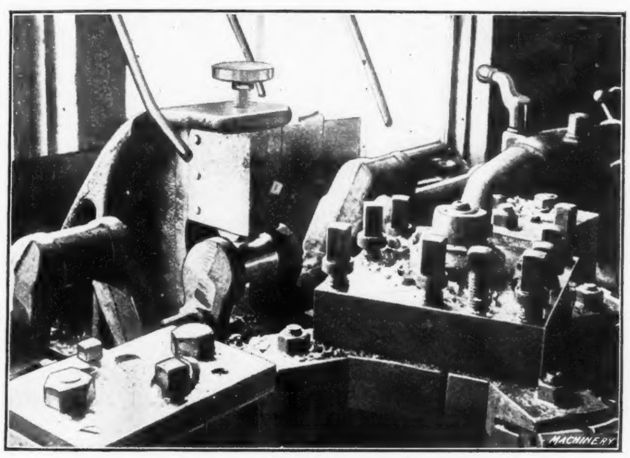


Fig. 3. Facing up Crankshafts to provide the Necessary Wheel Clearance

of cut) which gives a volume of 1.210 cubic inch. For the four pins the volume of metal removed is 4.840 cubic inches or 1.35 pound. From this data and the total cutting time for four pins of 5 minutes 45.4 seconds, the time required to remove one cubic inch of metal is found to be 71.4 seconds. Doing the same for the spot-centering operation on the center bearing, the time per cubic inch of metal is found to be 73.5 seconds. These calculations are based on cutting time only. In the first case, 40¼ per cent must be added to the cutting time to get the total time. In the second case, 44½ per cent must be added. These percentages represent the average of many sets of data, which, however, run surprisingly uniform, so much so as to establish 45 per cent as the limit of the ratio of "lost time" to "cutting time."

It was found that with the shortest finishing operations, such as took a total of thirty to forty seconds, elementary standards were impractical. These operations were performed so quickly that the changing and calipering occupied from 70 to 90 per cent of the time, and so only standard totals for these operations on the crankshaft were arrived at, which are as follows:

Grinding taper	42.5 seconds
Grinding gear fit	33.4 seconds
Grinding short pilot on flywheel end.......	31.4 seconds
Grinding long pilot on front end..........	43.6 seconds

In fact, the finish-grinding is found to be quite different from roughing. The amount of metal left for this operation was 0.040 inch on the diameter. However, the depth is so small and the surface covered so carefully in order to produce the finish that it is area rather than volume which must be considered. The finishing operations involving a larger area were found to have a nearly constant handling time ratio. An allowance of 77½ per cent was added to the actual grinding time on the pins and 74 per cent on the bearings. These are well within the 5 per cent limit of variations, though they are much larger than the additions to

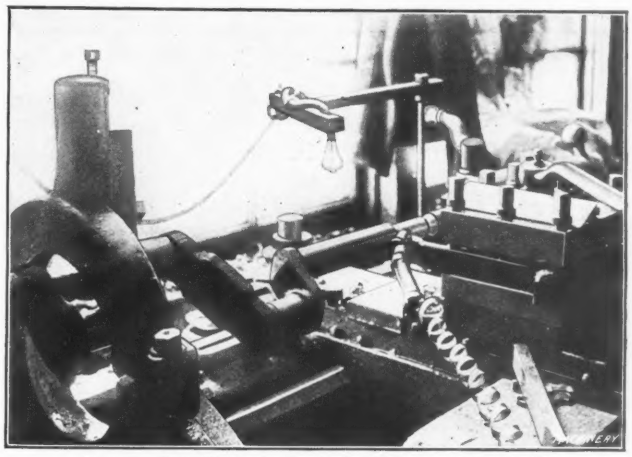


Fig. 4. Roughing out the End Bearings on the Lathe

the roughing time. This is undoubtedly due to the additional care necessary in grinding to the quarter thousandth limit placed on this class of work.

As to the cutting time, those operations involving no longitudinal motion of the wheel were found to require considerably more time per unit of area than those where the wheel could be run in to a certain depth of cut and then the whole length of bearing reduced to that finished dimension by a longitudinal motion. The first class of operation, such as finish-grinding the pins, is done on a 14 by 50 inch Norton grinding machine with a 24-N wheel. At the time of the test, the actual diameter was 23¼ inches, and when running at 955 R. P. M. a surface speed of 5820 feet per minute is attained. The work is revolved at 316 R. P. M., which, with a diameter of 1½ inch, gives 124 feet per minute as the surface speed. After grinding six shafts it is necessary to dress the wheel. A "Star" dresser is used to rough-dress it, since the wheel must be cut down half the depth of the 3/16 inch fillet in the angles. The surface is finished by a diamond held in the traverse. Finally, the fillet is hand-finished with the diamond until a test made by grinding a thin piece of board exactly fits the templet. This takes 10 minutes 12 seconds or 1 minute 42 seconds per shaft. The average

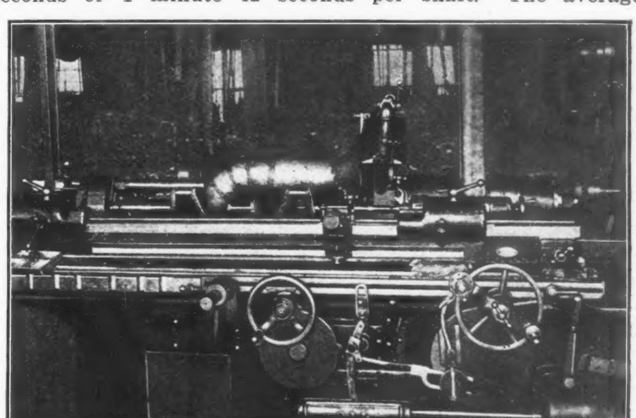


Fig. 5. Grinding the Gear Fit on the Norton Grinder

cutting time per pin was 1 minute 11.25 seconds, making a total of 4 minutes 45 seconds. The total time including changing the work and wheel dressing was 8 minutes 26 seconds. Each pin is 2¼ inches long by 1½ inch in diameter, which gives a surface of 10.6 square inches. This gives a cutting time of 6.73 seconds per square inch for finish-grinding to a depth of 0.020 inch. For this operation, no spacing bar is used, since the lateral limits on the position of the bearings are not close.

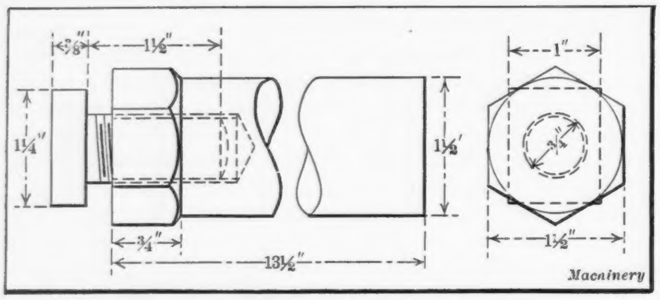


Fig. 6. Detail of the Driver shown in Operation in Fig. 5

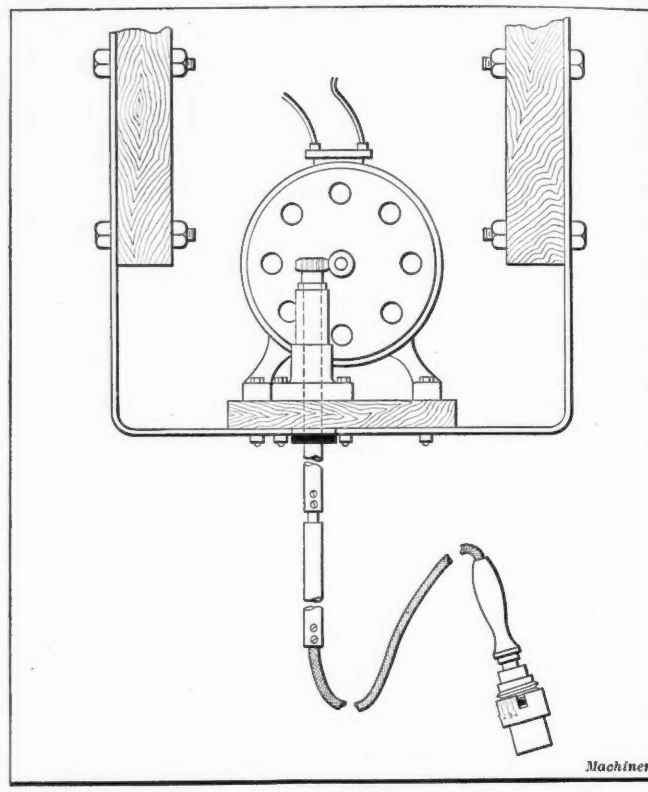
The other finishing operation is made up of both of these types of work. The wide end bearings are finished by moving the work lengthwise in front of the wheel. The center bearing involves the "running in" cut, but here the lateral limits of position are close and so it becomes necessary to work much more carefully. A standard cutting time of 7.93 seconds per square inch is the best speed consistent with good workmanship. The bearing is 2¾ inches long and 1½ inch in diameter, giving an area of 13 square inches. This work is done on a 10 by 50 inch Norton grinding machine, using an N grade wheel 18¾ inches in diameter revolving at 1170 R. P. M. or 5745 feet per minute. The work is 1½ inch in diameter and runs at 150 R. P. M., which gives a surface speed of 58.8 feet per minute. The wheel is dressed every ten shafts and the time required is 9 minutes 21 seconds.

If the forgings are coming very regular a somewhat different procedure is followed: Twenty-five shafts are ground and then the wheel is dressed for the fillets and the whole twenty-five shafts are then re-run to check up the fillets. This reduces the wheel cost and dressing time per crankshaft and gives fully as good a fillet. A grinding dog is used in this operation and the feed is by hand. The cutting time on the center bearing is 1 minute 43 seconds. For the end bearings, the times are 59 seconds and 49 seconds, respectively. The long one is 4.8125 inches long and the other 3 inches long. The total area is 7.8125 inches in length by 1½ inch in diameter or 36.9 square inches. The time is 1 minute 48 seconds or 2.93 seconds per square inch. The reason this time per square inch is so much less than the other standard is that the longitudinal motion covers the area far more quickly. The total time for grinding the three bearings, including changing and dressing the wheel, is 6 minutes 7.5 seconds.

The total time involved in machining each of these crankshafts is approximately 69 minutes, the time being distributed as shown in the accompanying table. Those times given in minutes and fractions are averages for irregular operations where the work varies for each individual crankshaft. Those given in minutes and seconds are for operations of a uniform character, which allow an exact duplication of motions in performing the work on each shaft. It may be of interest in this connection to mention the diamond cost which was $0.02375 per crankshaft; the wheel cost which was $0.075 and the scrap cost, which was $0.06927. These figures are arrived at by dividing the average seasonal cost by the average seasonal production. During all this test, no attempt was made to speed the work beyond limits which could be kept up indefinitely. The whole endeavor was to determine a standard rate for grinding surfaces and to observe the conditions under which this is done.

AN ELECTRICAL NUT SETTING ARRANGEMENT

In assembling the Witherbee igniter in the company's factory at Springfield, Mass., an ingenious arrangement is employed for setting the nuts on the hard rubber cases by power. The illustration shows the method of mounting the ¼ horsepower electric motor from the ceiling. This motor is speeded to 1800 R. P. M. and from the end of the armature shaft a worm meshes with a worm-gear on a vertically positioned shaft that extends down toward the floor. From the end of this shaft is extended a flexible shaft, and at the end



Electrically-driven Nut-setter

of the flexible shaft is an Errington nut setter. This nut setter works on the friction principle, so that when the nuts have been set up to the correct tension, the friction slips. With this device a man is able to do a large number of nuts per day, and in addition to being faster, the work is more thoroughly done and there is no danger of cracking the hard rubber plates.

C. L. L.

TIME REQUIRED FOR MACHINING CRANKSHAFTS

No. of Operation	Name of Operation	Type of Machine Used	Time	
			Minutes	Seconds
1	Snag	Emery wheel	1	
2	Cut off and center	Saw and centering lathe	4	
3	Straighten	Straightening press	3	
4	Spot center bearing	Grinding machine	2	32.25
5	Turn shoulders and short line bearing	Lathe	7	37.00
6	Turn long line bearing	Lathe	8	2.50
7	Rough pins	Grinding machine	8	18.70
8	Finish grind pins	Grinding machine	8	26.00
9	Finish grind bearings	Grinding machine	6	7.50
10	Finish grind short pilot	Grinding machine		31.40
11	Finish grind short pilot	Grinding machine		43.60
12	Finish grind taper	Grinding machine		42.50
13	Finish grind gear fit	Grinding machine		33.40
14	Cut off and thread	Lathe	1	30
15	Drill balance	Drill press	5	
16	Grind balance	Emery wheel	5	
17	Mill flat spot	Milling machine	1⅛	
18	Mill Woodruff keyway	Milling machine	1⅛	
19	Flywheel keyway	Milling machine	1	
20	Drill oil hole	Drill press	1	
21	Drill pin hole	Drill press	1	
			68	50.85

Machinery

PRODUCTION TOOLS FOR REO ENGINE CYLINDERS*—1

SPECIAL JIGS AND FIXTURES, AND MACHINING METHODS USED BY THE REO MOTOR CAR CO., LANSING, MICH.

BY DOUGLAS T. HAMILTON†

No better example of interchangeable manufacture and the development of special jigs and fixtures is obtainable than can be found in the production of automobile engine cylinders. When we consider the number of operations necessary on an automobile engine cylinder casting and the exactness to which the various surfaces must be machined, it is little short of marvelous that this work can be accomplished in such a short time and at such a low unit cost. The methods and jigs and fixtures employed by the Reo Motor Car Co., Lansing, Mich., are described in the following. The manufacturing steps from the time that the casting is received from the foundry until it is ready for assembling in the completed engine are described in detail. Fig. 1 shows the automobile engine casting. It is of the two-cylinder *en bloc* type and is used in a four-cylinder 30-horsepower engine.

Preliminary Operations on the Automobile Engine Casting

The first operations on the automobile engine casting after it is received from the foundry are inspecting, snagging and removing all objectionable fins. After it has passed through these preliminary operations it is placed in a testing fixture and given a water test at a pressure varying from 200 to 210 pounds per square inch, which exceeds, by about 175 pounds, the normal pressure in the water jacket when the engine is in use.

Milling Top and Bottom Faces of Casting

The preliminary machining operation, which consists in milling the top and bottom faces *O* and *P* of the cylinder casting, see Fig. 1, is accomplished, as shown in Fig. 2, in a Pratt & Whitney Lincoln type milling machine. Two castings *A* are held in this fixture at a time, but it is not of the reciprocal type. Fig. 3 shows in detail the construction of this milling fixture, and by referring to the latter illustration, the method of holding the cylinder castings will be clearly understood. The casting is located between four jaws *B* and *C*, which are operated by left- and right-hand screws, actuated by two handwheels *D*, only one of which is shown. The base of these jaws slides in T-slots formed by machine steel strips which are fastened to the top face of the base casting of the fixture, and the vees of these jaws grip the cylinder casting around the circular portion, as indicated in Fig. 2. To prevent the thrust of the cut from loosening the jaws, a special clamping strap *E*, operated by the lever *F*, as shown in Fig. 2, is provided. This is put in place and tightened after the casting has been located and clamped in the fixture.

The milling is accomplished by two 5½-inch diameter inserted-tooth high-speed steel milling cutters which take a depth of cut varying from 3/16 to 1/8 inch. The cutters are rotated at a peripheral speed of 30 R. P. M. and the table travels at a rate of 1/16 inch per revolution of the cutters. The jigs held on this table are of the individual type, and in operating it is necessary to mill the two castings before starting on a second cut. However, the time of operating is reduced by unloading the first casting that is milled while the second one is being operated upon, and loading the second

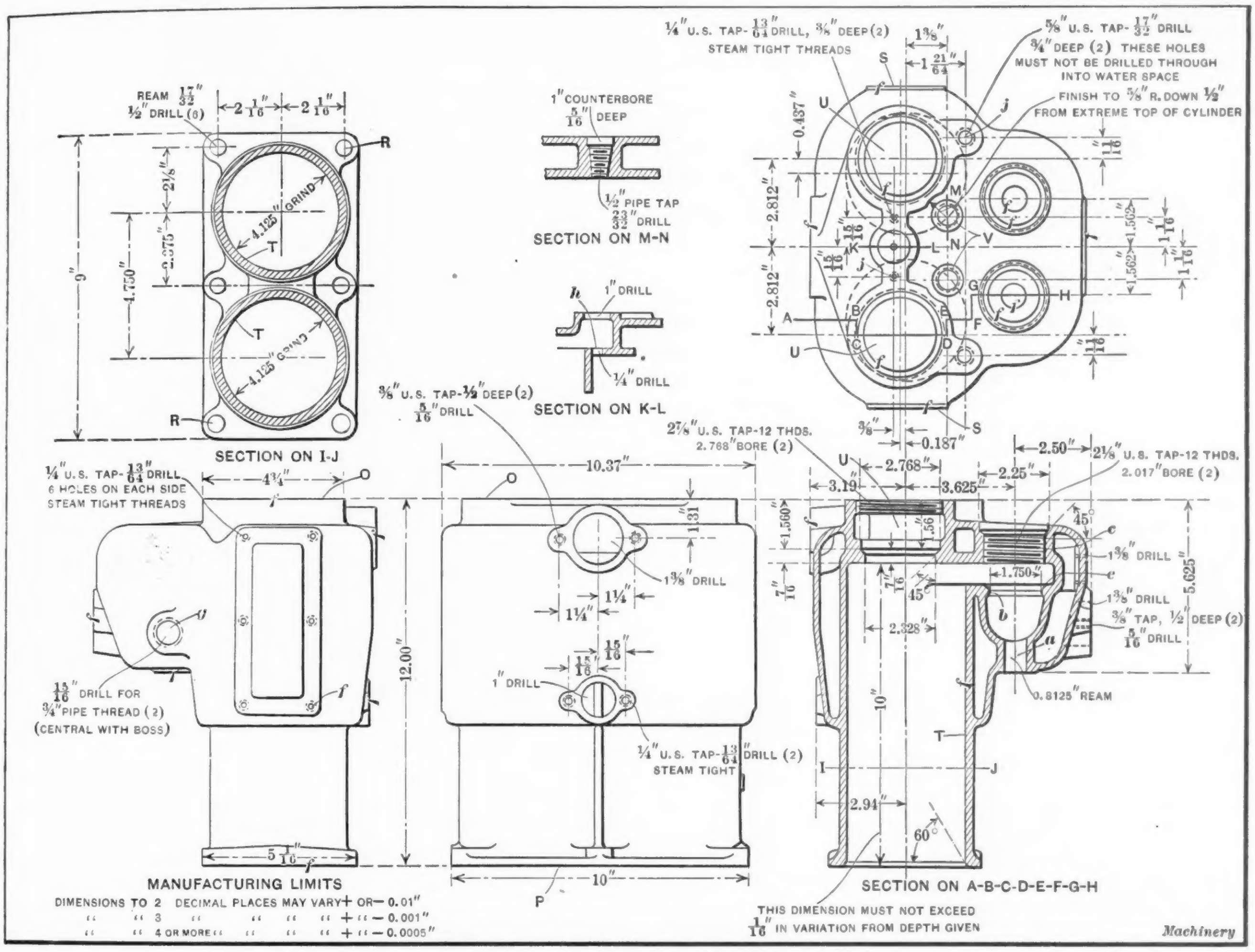


Fig. 1. The Reo Engine Cylinder—the Subject of this Article

* For information on automobile shop practice previously published in MACHINERY, see "Forging and Machining Automobile Front Axles," December, 1913; "Automobile Manufacturing Methods," July, 1913; "Shop Practice of the Willys Overland Co.," February, 1913; "Some Tools used by the Gramm Motor Car Co.," January, 1913; "Processes in Production of Automobile Transmission Gears," July, 1912; "Methods, Machines and Fixtures for Automobile Manufacture," December, 1911, and articles there referred to.

† Associate Editor of MACHINERY.

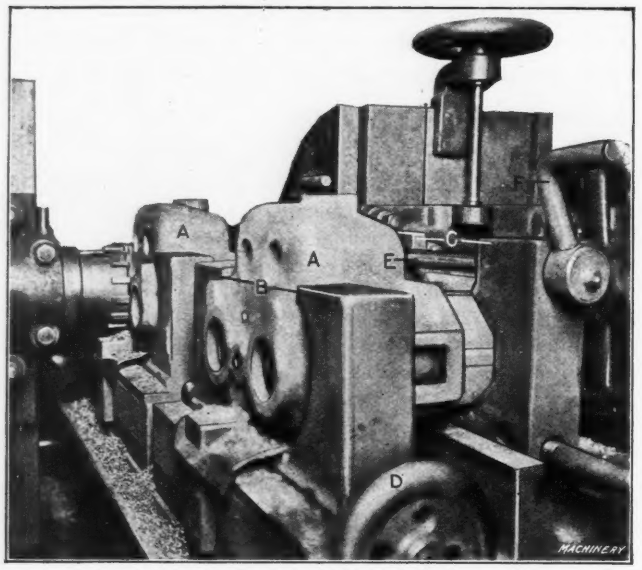


Fig. 2. Milling the Top and Bottom Surfaces of the Cylinder Casting

fixture when the casting in the first one is being machined. The casting in the first fixture, however, cannot be replaced until the table of the machine has been brought back to the starting point. Nevertheless, very little time is lost in operating, as a production of one hundred and thirty-four completed castings in nine hours evidences.

Drilling and Reaming the Flange Holes in the Base of the Cylinder Casting

Upon the completion of the milling operations just described, the next step is to drill the holes in the flange, through which the bolts pass that fasten the cylinder castings to the crank-case. These holes also act as locating points in all subsequent operations. Although this operation is of a simple character, the method of accomplishing it is rather interesting, as Fig. 4 will show. The drilling and reaming of the six flange holes *R* (Fig. 1) is accomplished progressively in a Baush multiple spindle drilling machine. The type

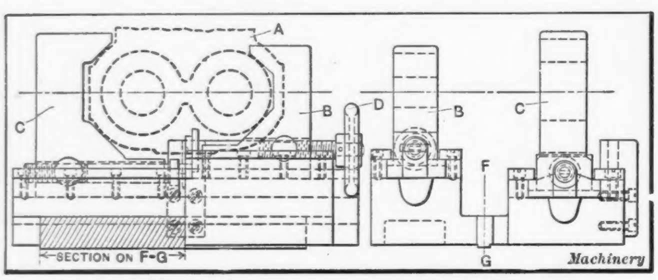


Fig. 3. Milling Fixture used for holding the Cylinder Castings in the Machine shown in Fig. 2

of fixture used is not only of novel construction, but incorporates some points in design that facilitate interchangeable manufacture. As will be seen upon reference to Fig. 4, this fixture is of open construction and consists primarily of a frame *A*, to the top faces of which two rails *B* are fastened. Sliding upon these rails are the work-holding fixtures to which the cylinder is clamped bottom side up.

A more detailed view of the construction is shown in Fig. 5, to which reference should now be made. Upon referring to this illustration, it will be seen that the cylinder casting *D* is held to the bottom face of the sliding portion *E* of the jig by two long clamping bolts *F* and a cross-bar *G*, in which a clamping screw *H* is located. This screw is used to hold the cylinder casting up tight against the bottom face of the jig. The casting is located in the proper relation to the bushings in the top face of the jig by two jaws *I* operated by means of a left- and right-hand screw that receives motion from the handle *J*. These jaw members slide on the top edges of the jig, and have under ledges on which the flange of the cylinder base rests.

Referring now to Fig. 4, the method of operating the fixture is as follows: three work-holding jigs of the type illustrated are in use. The operator first places one jig under the six drills which are 1/2 inch in diameter, and are rotated at 220 R. P. M. The machine is then operated and the drills pass through the 5/8-inch flange. This first jig is then shifted over into the reaming position and the second jig put into place. The machine is again operated and while the holes in the second casting are being drilled the holes in the first casting are reamed by six reamers 17/32 inch diameter; these are

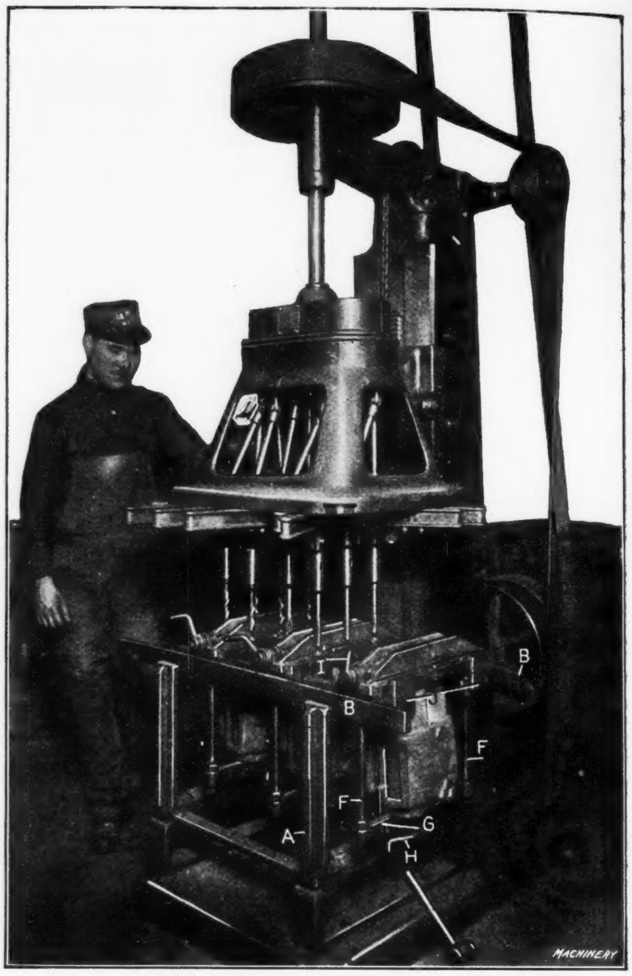


Fig. 4. Progressive Drilling and Reaming of Flange Holes in the Base of the Cylinder Casting

rotated at 220 R. P. M. and the downward travel of the head is 0.005 inch per revolution of the reamers. The third or extra jig is then brought into position and the operations repeated. When the fixture has once started to work in this order, a casting is drilled and reamed at each downward movement of the head. The third jig enables the operator to remove and clamp another casting in position while the machine is

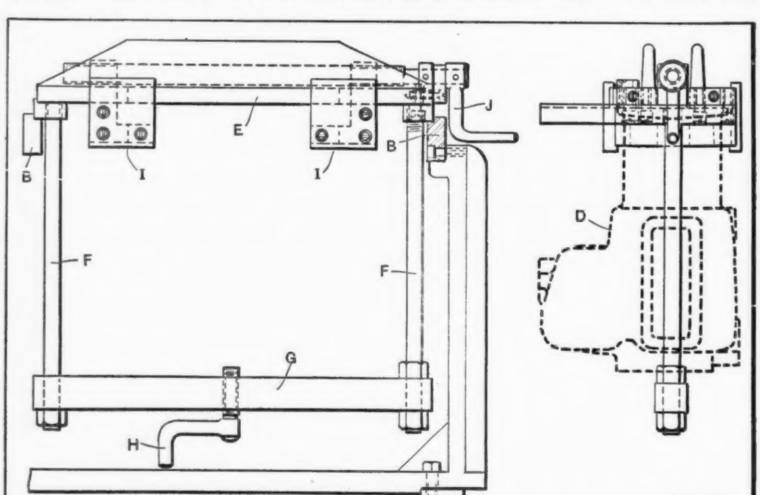


Fig. 5. The Progressive Drilling and Reaming Jig

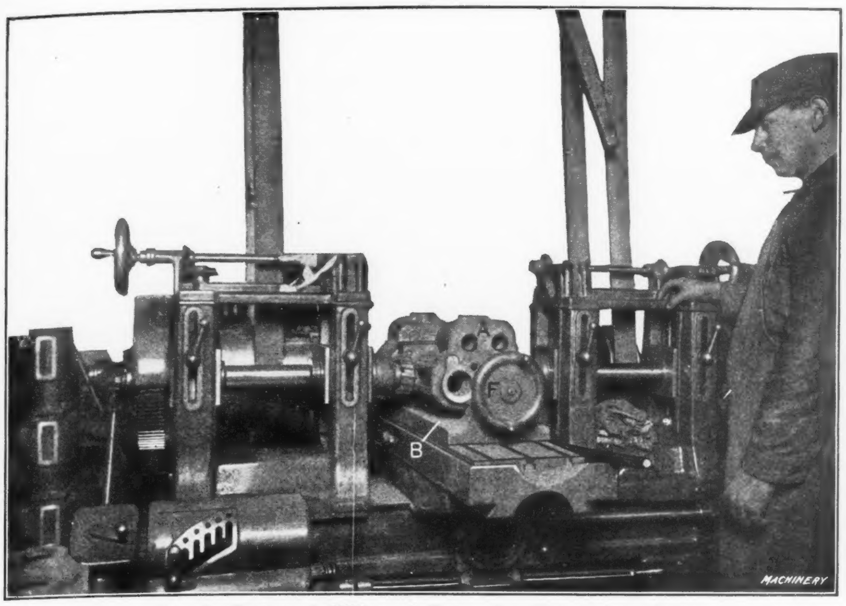


Fig. 6. Reciprocal Milling of Bosses for Waterjacket Plates

in operation, so that the drilling and reaming of the castings is practically continuous. The production from this machine is high, averaging about 210 completed cylinder castings in nine hours. The method of handling the work is, of course, largely responsible for this production. The jigs are provided with removable bushings so that they can be run along progressively on the rack and allow the drilling and reaming operations to be accomplished through the same jig simply by changing the guiding bushings.

Milling Bosses for Water Connection Plates

Following the drilling and reaming of the six holes in the flange of the cylinder casting, the next operation is to face

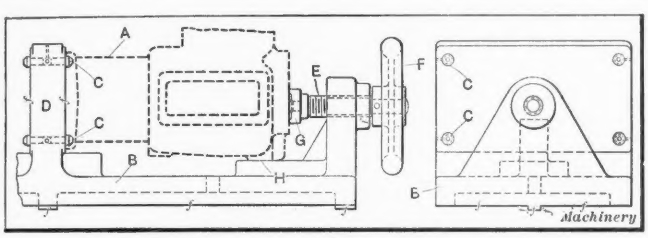


Fig. 7. Detail of Reciprocal Milling Jig shown in Fig. 6

off the bosses *S*, Fig. 1, for the water connection plates. There are two surfaces machined on each casting and this work is accomplished in the Lincoln type milling machine shown in Fig. 6. Two high-speed steel inserted-tooth milling cutters are used for this purpose, and two castings are machined at one setting. This fixture is of the reciprocal milling type, enabling the milling operation to be carried on practically continuously. Fig. 7 shows the type of fixture that is used, and upon reference to this illustration it will be seen that the bed of the fixture consists of one casting *B* which is fastened to the table of the milling machine. The cylinder casting is located in the correct position by four hardened studs *C*, fitting in the previously reamed holes in the flange, and is held tight up against the center bracket *D* of the fixture by the screw *E* operated by handwheel *F*. The forward end of this screw is provided with an adjusting clamping head *G* which accommodates itself to the surface of the cylinder casting, holding it tight against the machined face of the fixture. The casting *A* also rests on a projecting boss *H* on the fixture. As this fixture is worked on the reciprocal principle, it is evident that the production will be greater than that shown in Fig. 2. In this case 140 of these castings are machined in nine hours as against 134 in the first milling operation. The depth of cut taken from each side varies from 1/8 to 3/16 inch and the length of surface milled on each casting is approximately 6 1/16 inches.

Rough- and Finish-boring Cylinder Operations

In order to avoid the difficulties that would result from striking hard and soft castings when boring, the Reo Motor Car Co. has followed the plan of testing all the castings before boring with a scleroscope. The average run of castings strike between 30 and 40 on the scleroscope, and any that strike higher than this are laid aside, marked as hard and machined separately. By following this plan, it is possible to get an average product from the machine each day without running up against any serious difficulties because of hard cylinders. The operator also has less trouble with the cutters because he knows before he puts the casting in the machine whether it is hard or of a uniform density. The same operator who runs the Foote-Burt cylinder boring machine shown in Fig. 8 also tests the cylinders for hardness before clamping them in the jig. The boring machine illustrated is of the four-spindle construction, and machines two cylinder castings or four bores in one setting. On an average, 5/16 inch of material is removed from the diameter of the cylinder bores *T*, Fig. 1, at a rate of feed of 0.063 inch per revolution, leaving it 3.965 inches in diameter by 10 inches deep.

The type of fixture used for holding the castings while rough-boring the cylinders is shown in Fig. 9. Referring to this illustration, it will be seen that the fixture *A*, which consists primarily of a cast frame, is of open construction and is provided with work-holding slides *B* which fit in V-ways provided in the top part of the frame of the fixture. The cylinder castings are located on these slides from the previously drilled and reamed holes in the flange, and are held in position by heel-clamps *C*. The slides *B* are then pushed into the fixture and located by the plug *D* that fits in a bushed hole in the slide and serves to locate the slide in the correct relation to the boring spindles of the machine. In order to provide a support for the casting at its lower end, two tapered wedges *E* and *F* are added to the fixture which assist in holding the casting tight against the slide, and prevent any twisting action due to the boring tool shifting the casting when the bore is eccentric. The top part of this fixture is tied with a tie-bolt *G*, which holds the slides rigidly and prevents any side motion. The nuts on these tie-bolts are released when removing the work-holding slides.

Fig. 8. Rough-boring the Cylinder in a Foote-Burt Cylinder Boring Machine

This rough-boring cut is extremely hard on the machine and cutters because of the large amount of material removed, and also because of the fact that the skin material or surface is much more difficult to cut than the interior or softer metal. Considering this, 124 completed cylinder castings in nine hours shows that the method of machining is about as complete as it could be. Four work-holding slides are provided for this machine so that while the machine is in motion the operator can be removing two finished cylinder castings and clamping two rough ones on the extra slides, thus reducing to a minimum the time that the machine stands idle between loadings.

The second rough-boring cut is accomplished on a Moline four-spindle cylinder boring machine which is equipped with a fixture similar in construction to that shown in Fig. 9. In this case, a cut 0.105 inch on the diameter is taken, and the fixture instead of being loaded from the front as was the case with the rough-boring fixture shown in Fig. 8, is loaded from the end. The production from this machine is 134 completed cylinder castings in nine hours. Before taking the finish-boring cut on the cylinder, the other operations on the valve seats and similar parts are performed and the finish-boring is left until last before the castings are taken to the cylinder grinding machine. These operations will be described in a following article.

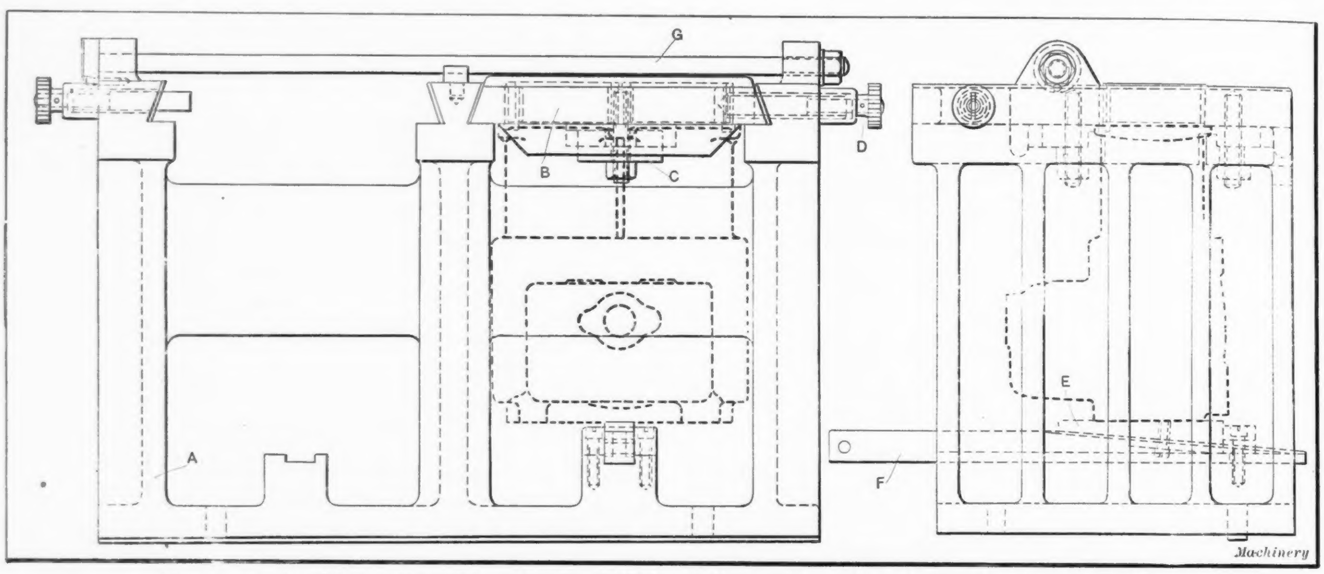


Fig. 9. The Rough-boring Jig which carries Two Cylinder Castings and is used in the Machine shown in Fig. 8

* * *

METHOD OF SECURING CELLULOID TO WOOD

BY G. G.

I recently had occasion to fasten pieces of sheet celluloid to some narrow strips of wood. One side of these strips was completely covered with fine graduation lines and figures so that it was impossible to use small brads to secure them in place. I tried several different kinds of mucilage and glue but met with little success, as the best glue that I found only held for two days.

If the reader ever happens to run across a job of this kind he need not give up hope, as it is quite an easy matter to deal with if you know the proper way to proceed. The method I finally hit upon is as follows: After scraping the wood and celluloid absolutely clean, heat some grain alcohol to the boiling point. As alcohol boils at a relatively low temperature and is very inflammable, it should be held at a considerable distance from the source of heat. When the alcohol has been warmed to the desired point, it is applied to the under side of the celluloid with a small brush. The celluloid is then pressed down on the wooden strip to which it is to be secured and held tightly in place for about two minutes. After that time, nothing except fire will ever make the celluloid come off. The same method may be used for sticking celluloid to celluloid, celluloid to hard rubber and celluloid to glass.

HOW SOME UNUSUAL JOBS WERE HANDLED

BY W. D. FORBES*

In every machine shop in the country there are certain jobs which can be done more or less rapidly and more or less well, as they present no great difficulties. For instance, a pair of parallels 2 inches square could be gotten out so that they would be perfectly serviceable and parallel by any shop that has a planer, as, of course, the work would be accomplished by planing up a long strip and then parting it. This, of necessity, would produce two similar pieces. But when it comes to certain classes of work, the question of how it is done or whether it can be done at all in the shop is interesting.

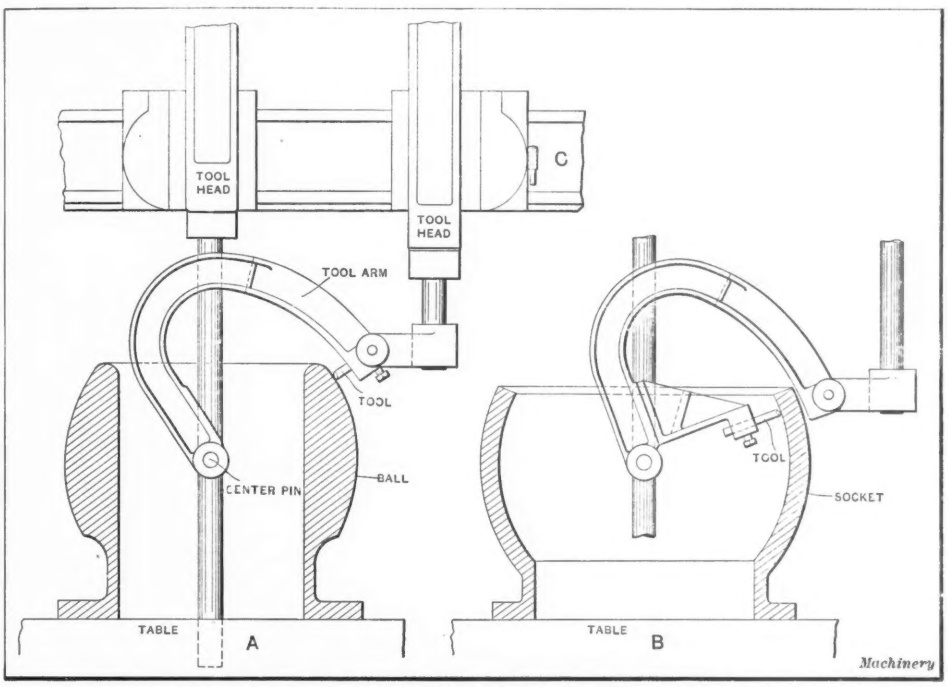
How many shops could produce a strip of steel ½ inch wide by 0.0015 inch thick and do it commercially? I once tried this very job and made a big failure of it as far as the commercial side went, although I managed to get a couple of strips down to the 0.0015 inch dimension. I had just installed a new surface grinder and felt that I could grind anything that could be ground, so I accepted the job of making two of these thin pieces. I made a cast-iron block and planed it up, filed off the two ends to an easy curve and stretched the strip, which was about 0.0025 inch thick, across it. I thought this would work all right, but after several trials found that, even with a good supply of water, the heat generated was too great. Finally I resorted to hitching a stout spring to one end of the strip, that is, the end where the emery wheel left the work, and by putting a tension on the spring and on the strip, I finally managed to get a couple of pieces down to size at a cost of about eight or ten times what I got for them. Upon telling a friend of my experience, he said that my grinder should have been replaced by a pair of rolls, and that if I had used these I could have gotten down to size without any trouble. This may be perfectly practical for those who understand rolling metals, but it isn't really a machine shop job.

Another job which would puzzle a machine shop would be to put a ⅜-inch hole through a piece of steel 28 inches long, and have the hole true and to size; yet any gun barrel maker would do this without difficulty. Probably everybody who has run a machine shop has had a customer tell him that he is quite privileged to suggest any change in the work which will reduce the cost of machining. This really means that the change will allow the person wanting the work done to make a little more money and the manufacturer, himself, to get less work as a result. It is most magnanimous, of course, but the manufacturer usually rather fails to see the point.

A certain firm required a number of cross-head guides, which were to be used in some horizontal air-compressors, and the job was being estimated on by a shop that was very

* Address: New London, Conn.

anxious to get the work. The privilege of suggesting changes in the design was offered, and after considering what could be done, the shop put in a bid and was successful in obtaining the work. The following alteration was made: The castings weighed about forty pounds each and were of a channel form; they had to be planed off on the top to receive the gibs, and down in the channel to receive the cross-head shoe which was of composition. The original design had oil pockets at each end of the channel, which the draftsman had shown with a lip projecting above the bottom of the channel. This would have made it necessary to machine these cross-head guides singly if a planer was used as, of course, these lips interfered with a continuous cut when several of the cross-head guides were set up together on a planer. These oil pockets were cut off the pattern and a separate pattern made; the pockets were then screwed into position on the finished guides. It is clear that by stringing the cross-head guides along the table the planer tool could sweep through the whole group, making them all alike and saving considerable time, the planer having to be reversed only once for half a dozen guides for each cut. Just as many reversals would have had to be made for each guide had the oil pocket been left as originally designed, to say nothing of the multiplicity of measurements when handling the cross-head guides singly.



Device for turning a 36-inch Ball and Socket on the Boring Mill

Now how is it that a machine shop is so often confronted by just such a condition as the one here noted? It will be admitted at once that, when looking over the men in most drafting offices, you will see very few gray heads; and while gray hairs are a great objection they do, at times, denote experience, and that is of value. The young draftsman usually comes from a technical school and can make good drawings, but his lack of shop experience seems to me to give a clear reason why impractical designs are so often met with. Yet where is the chief draftsman? What is the superintendent doing to allow designs to be gotten out by inexperienced men without thoroughly overhauling them with a view of obviating unnecessary work? Most superintendents and chief draftsmen will say in answer to this question that if they were twins they might be able to look over all the details; in other words, that they have no time to properly consider the work of those they employ. This is all well enough in a way, but in every machine shop there are bright men, not necessarily young, who know all the tools in the shop, just what can be done on them and what is a good practical way to do it.

Another illustration in connection with these very cross-head guides: The gibs were designed to have countersunk fillister head screws to hold them in place and the tapped holes in the cast-iron cross-heads were shown to go down about seven-eighths into the cast iron for tapping. A quarter of an inch more drilling and there would have been a through hole. Now everybody knows that a through hole can be more quickly drilled than a depth hole and that it can also be more quickly tapped. Some will not quite agree with this but the practical man who is doing the work will. He will tell you that, with all care, stops on a drill-press slip and that tapping machines sometimes don't reverse just when they should. The countersinking for fillister heads was quite unnecessary, as there was nothing to interfere with the use of cap-screws which saved counterboring and such screws are infinitely handier than the slotted head affairs.

Speaking of slotted heads in screws, I have always wondered how it was that an English patent on screw-heads never became popular. It was shown me years ago by Mr. T. A. Weston, of differential pulley-block fame, and in my opinion he ought to have a monument erected to him for his invention. This screw-head would be more generally used for wood screws than for machine screws. Instead of having a single slot cut across the head, it had two slots at right angles, forming a Greek cross. If this was all it would not have amounted to much; but these slots converged toward the center and were sunk deep in the screw-head, the slots themselves tapering in width from the center to the edge of the screw-head. The screw-driver was of a form to fit down into these recesses, and as they were tapering and converging one size of screw-driver answered for several sizes of screws. You could put a screw on a screw-driver held vertically and the screw would not drop off; and a screw could be gotten out or else the entire body twisted off. Mr. Weston told me that these slotted screw-heads were made by being struck up in the machine that made the head and at the same time the head was formed. I never saw the machine work but I saw samples of this screw and I certainly wish that it had come into existence. Perhaps some of the readers can shed further light on what seems to be the sidetracking of a valuable idea.

* * *

BALL AND SOCKET TURNING DEVICE

BY L. D. PEIK*

In the shop where the writer is employed the operation of turning a ball was one which usually gave considerable trouble, and this was especially true of balls of any considerable size. In the accompanying illustration *A* shows the ball and *B* the socket for a ball and socket joint 36 inches in diameter, which was used on a suction pipe line. This ball and socket were both finished on a boring mill by means of the device which forms the subject of this article. The left-hand tool-head holds the bar which centers the tool-arm, this bar being supported at its lower end by a bushing in the table. It will be seen that the center pin holds the split tool-arm, the opposite end of this arm being supported by a yoke fastened to the right-hand tool-head. The right-hand tool-head is loosened slightly on the saddle and the screw *C* is removed to give the feed motion a free swing on the saddle, to allow it to follow the arc described by the tool-arm.

The proper arc of the ball is made by feeding down the right-hand tool-head while the left-hand head remains stationary. The socket is bored in a similar manner by means of a tool-holder bolted to the arm on the inside as illustrated at *B*. This device has been in use for some time and the writer has found that there is very little chattering of the tool on the finishing cut if the bolts on the saddle are kept adjusted.

* Address: Care of Bucyrus Co., South Milwaukee, Wis.

COMPOUND STRESSES

ELASTIC LIMIT WITH COMPOUND STRESSES, AND THE MAXIMUM SHEAR THEORY

BY SANFORD A. MOSS*

THE elastic limit of a material is found by subjecting it to direct tension or compression in a testing machine. It gives a value which must be borne in mind in using the material in engineering structures. It is obvious that the conditions must be the same as existed in the testing machine, that is, there must be simple tension or compression. Examples of such stresses are found in the bursting stresses in thin pipes, centrifugal force stresses in rotating thin rings, tension on wire ropes and bending stresses in beams near the places where the stresses are maximum. In each of these cases the conditions are exactly the same as in the case of a specimen in a testing machine, so that the values of elastic limit are directly applicable. These are cases of simple stress.

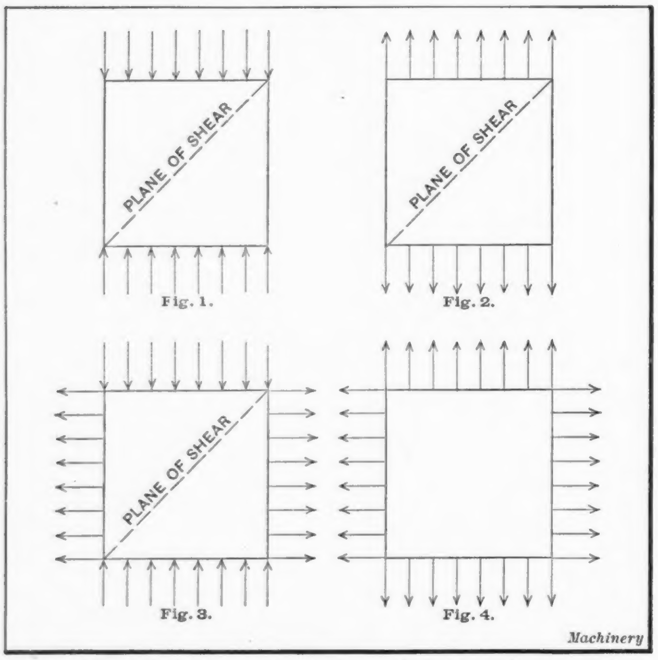


Fig. 1. Shear due to Compression. Fig. 2. Shear due to Tension. Fig. 3. Shear due to Combined Tension and Compression. Fig. 4. Tension in Two Directions. Maximum Shear is inclined at Angle of 45 Degrees to Plane of Paper

Another class of cases arise, however, in which there are stresses in two or three directions at the same time. These are called compound stresses. An example of this is found in a long thin cylinder closed at each end and subjected to internal fluid pressure. There is a tangential stress which tends to burst the cylinder along a line parallel with the axis, as well as a longitudinal stress, due to pressure on the heads, which tends to tear the cylinder apart in a plane perpendicular to the axis; that is to say, a small square in the wall of the cylinder is subjected to stress in two directions, each at right angles to the other. Examples of similar cases are found in stresses due to combined bending and twisting in a shaft, stresses due to centrifugal force in a rotating wheel disk, and stresses in a hub pressed on a shaft.

The Elastic Limit Question With Compound Stresses

The question then arises, What is the criterion for safety in the cases above, equivalent to the value of the elastic limit in cases of simple stress?

A very unfortunate thing in engineering has been the fact that it has not been realized until very recently that there is any necessity for a criterion. Two different classes of engineers have each tacitly assumed a certain criterion, discussed later as the "maximum stress theory" and the "maximum strain theory," without realizing that they have made an assumption in the matter, supposing that their ideas were *apriori* correct, and that there was no other possibility. As an actual fact, no *apriori* assumption is possible, and the matter is one which must be made the subject of very careful experiment. It has only been in very recent years that such experiments have been made. Most engineers who have studied the existing experiments carefully have agreed that neither of the old theories is correct, but that a new one, the "maximum shear theory," must be adopted. The fundamental principles at the root of the whole matter are not popularly understood, and it is the purpose of this article to go into details regarding them. In the writer's opinion, it is completely settled that the maximum shear theory is the proper one for ductile materials such as steel. The writer believes that any engineer who will take the time to investigate the matter completely will be convinced of this. Many engineers use the older theories for the reason that they have started out this way, and have never realized that there was any question in the matter.

Cross Contraction and Net Strain

A simple tensile stress causes elongation in its own direction, as given by the modulus of elasticity. That is, if E is the modulus of elasticity, the total elongation l produced in a piece of length L by a stress S is given by the well known law:

$$E = \frac{S}{l \div L}.$$

Not only does the stress in the given direction produce the extension mentioned in the direction of the stress, but there is also produced a contraction in each direction at right angles to the stress. That is, if we have a square bar stressed in the testing machine in the direction of its length, so that the length increases according to the above formula, there is a contraction in each opposite direction, which produces decrease in the thickness of the bar. The ratio of the contraction at right angles to a stress, to the direct extension, is called Poisson's ratio. For ordinary kinds of steel this has a value of 0.3. If the direct stress is a compressive stress, so as to cause decrease of length in the direction of the stress, then there will be an expansion in each direction at right angles equal to 0.3 times the compression. Suppose we have a bar 1 inch square, in compression, with such stress that every inch of its length is compressed 0.001 inch. Due to this compression the thickness of the bar will be increased in each direction 0.0003 inch.

This action of extension in one direction and contraction in the other, due to a simple tensile stress, exists for each such stress. When there are stresses in two directions at once, that is to say, when we have compound stresses, each of the individual stresses produces its deformation regardless of the existence of the other stresses. The total deformation produced is due to the sum of such individual deformations. Consider the case of a hub pressed onto a shaft. There is a stress in the radial direction which compresses the fibers in this radial direction. Due to this radial compression, there is extension in the tangential direction. There is also a stress in the tangential direction which tends to burst the hub across the diameter. This stress produces extension in the tangential direction and also compression in the radial direction. Consider now the material in that portion of the hub immediately next to the bore. This is a thin ring of metal the circumference of which is increased directly by the tangential stress. However, the compressive radial stress also tends to produce extension in the tangential direction, so that the total increase of circumference exceeds that produced by the tangential stress, if acting alone, by an amount which is 0.3 of the direct compression produced by the radial stress acting alone. Similarly, there is a decrease in thickness of the ring due to the radial stress directly, and a further decrease in the thickness due to the tangential stress.

In the case just considered one of the stresses was a tensile stress and the other a compressive stress, and the deformation in each direction was greater than that pro-

* Address: 36 Sachem St., Lynn, Mass.

duced by each stress acting alone. We may, however, have both stresses in the same direction, as in the case of a rotating disk, where there are both radial and tangential tensile stresses. The tangential stress tends to increase the circumference of any thin ring in the interior of the disk, but the radial stress, which causes extension in the radial direction, causes contraction in the tangential direction, so that the net increase in circumference is less than that due to the tangential stress acting alone. Similarly, the net increase in the thickness of any thin ring is less than that produced by the radial stress acting alone. If we have a direct stress S_1 it produces a deformation or increase in length in each unit of length, called "strain," amounting to $\frac{S_1}{E}$. If now we have another stress at right angles to the stress S_1 amounting to S_2, this stress produces, in its own direction, an extension in unit length, or strain, amounting to $\frac{S_2}{E}$. At the same time, this stress S_2 produces in the direction of the stress S_1 a contraction equal to $\frac{0.3\,S_2}{E}$. Hence the total extension per unit length, or strain, in the direction of the stress S_1 is:

$$\frac{1}{E}\,(S_1 - 0.3\,S_2).$$

If there are stresses in a third direction, we have to subtract still another term to get the net strain. If the three stresses are equal and of the same kind, the net strain is $(1.0 - 0.3 - 0.3)$ or 0.4 times that due to one stress.

In order to produce the same deformation in unit length, or strain, due to the stresses S_1 and S_2, we would have to have a simple stress equal to $S_1 - 0.3\,S_2$. Such an equivalent simple stress which would produce the same strain as the actual strain existing at any point due to the actual compound stresses, used to be called the "true stress." The actual stresses which we have been discussing and which are given directly by the forces acting on our material were then called the "apparent stresses."

Shear

When a short specimen is compressed in a testing machine, it fails by sliding of the upper part on the lower part at an angle of 45 degrees; that is, the direct compressive stress produces a tendency for the two parts to slide one on the other as shown by Fig. 1. This tendency to slide is called a shearing stress. A tensile stress also causes a tendency to slide. If a tension break in a homogeneous material is closely examined, it will be seen that the actual failure has been due to sliding at an angle of 45 degrees along a number of different faces, some inclined one way and some inclined another. In other words a tensile stress produces a tendency to slide, as shown in Fig. 2. Suppose now that we have in the same cube both tensile and compressive stresses at right angles. Then there is a combined tendency to slide, as shown in Fig. 3. If these stresses are both the same, the tendency to slide is double that produced by either stress if acting alone. It is obvious that in any case of a tensile stress in one direction and a compressive stress at right angles, there is a tendency to slide equal to that produced by a simple stress of an amount equal to the sum of the two existing stresses. That is to say, the shear produced by two stresses of opposite kinds in directions at right angles, is equal to the shear produced by a simple stress which is equal to the sum of the two stresses. When there are three stresses the shear is computed in a similar way which we will discuss later.

Stress Computation

The mathematical theory of elasticity, as it has existed for years, gives means for computing the actual stresses existing at any point of a body, or the "apparent stresses," as they are sometimes called, as well as the simple stresses which would produce equivalent strains, or the "true stresses," and the simple stresses which would produce equivalent shears. There is no difference of opinion about such computation. There are many matters in the theory of elasticity which are difficult of solution but such problems as can be solved are universally agreed upon. Hence, the matters which are not generally handled satisfactorily are not matters of theory of elasticity computation.

Criterion for Equivalent Simple Stress with Compound Stresses

If we had only to deal with simple stresses we would raise no question as to just what happens when the elastic limit is reached. The elastic limit and the beginning of failure may be a matter merely of the stress, or it may be a matter of the strain, or it may be a matter of the shear. However, conditions would be just the same in a piece in which we are interested as they are in the testing machine, so that we know that the beginning of failure, whatever it may be due to, would occur when the testing machine stress is reached. In the case of compound stresses, there is quite a different condition. We may have in a piece in which we are interested a stress which is safe in the testing machine and which would be safe if it existed alone. However, we have in addition stresses in other directions. If it were the direct stress only which counted, and if the existence of stress in other directions did not cause weakening in the direction of the greatest stress, such stress in other directions would be immaterial. On the contrary, if the limit of safety is fixed by the amount of strain or deformation which is permissible, then we would have to take account of stresses in all directions, since each of these produces a strain in any given direction. We would then have to compute the net strain in a given direction, due to all of the stresses taken together.

Suppose that if we had a direct tensile stress of 30,000 pounds alone, we would just be at the elastic limit. If now we have in addition a tensile stress at right angles, this would diminish the strain produced by the first stress, so that the net strain would be less than that corresponding to a simple stress of 30,000 pounds. Hence if net strain counts, our material would be strengthened by the existence of this second tensile stress at right angles to the first. On the contrary, if the second stress were a compressive stress, it would cause a strain which would have to be added to the original strain, so that weakening would result. A similar situation exists if it is shear which we have to attend to. A direct stress produces a certain shear and the existence of a stress at right angles produces additional shear which is to be added to or subtracted from the first, according to the direction of the second stress. The strain produced by two equal stresses at right angles, one tensile and one compressive, is 1.3 times the strain produced by either stress alone, while the shear produced by two such stresses is twice that produced by either stress alone.

It is obvious then that we must decide just what sort of action causes failure and just what conditions we are interested in, whether merely the stress itself, the strain, or the shear. Having decided this question, the theory of elasticity gives us more or less easy means for determining the value of a simple stress which in a testing machine would produce the same conditions as those existing in any case of compound stresses.

Maximum Strain Theory

The theory that has in the past been generally accepted is the maximum strain theory. So far as the writer knows there were never any experiments made to demonstrate its validity. It was probably reasoned out by some of the older elasticians purely as a matter of abstract philosophy, and probably considered by them as self-evident. The theory thus crept into use in an unobtrusive way without realization that there had been made an assumption that was not axiomatic. This theory is used in most of the older textbooks and writings, without discussion. This theory supposes that the thing which causes failure and which must be used as a criterion for safety is the amount of deformation or strain. With a modulus of elasticity, E, of 30,000,000, there is a deformation or strain of 0.001 inch in every inch of length with a simple stress of 30,000 pounds. If now 30,000 pounds is the elastic limit, then when we have compound stresses, failure will begin to occur whenever the net strain due to the action of all the stresses together becomes 0.001

inch per inch. This will occur, for instance, with a tensile stress of 39,000 pounds in one direction and a tensile stress of 30,000 pounds in a direction at right angles. Due to the first stress there will be an extension or strain in its own direction of 0.0013 inch in every inch of length. The stress of 30,000 pounds in the opposite direction will produce an extension in that direction of 0.001 inch per inch of length, and hence a contraction in the direction of the first stress equal to 0.3 of this, or 0.0003 inch. The net extension or strain in the first direction will therefore be 0.0013—0.0003, or 0.001. This is the same strain as produced by a simple stress of 30,000 pounds. In the same way a tensile stress of 24,000 pounds in one direction and a compressive stress of 20,000 pounds in an opposite direction may be shown to produce a strain of 0.001 inch in every inch of length. That is to say, according to the maximum strain theory a simple stress of 30,000 pounds per square inch is the stress equivalent in the results produced, so far as failure is concerned, to tensile stresses at right angles of 39,000 pounds and 30,000 pounds, or to a tensile stress of 24,000 pounds in one direction and a compressive stress of 20,000 pounds in the other direction. The well known formulas for stresses in a gun or thick tube, due to Clavarino for the case where there are heads in the end, and to Birnie for the case where there are no heads, are examples of formulas based on the maximum strain theory.

Maximum Stress Theory

The maximum stress theory supposes that failure and elastic limit are purely matters of stress in a given direction regardless of the existence of stresses in other directions. That is to say, if a stress of 30,000 pounds is the elastic limit for a simple stress in a testing machine, it will also be the elastic limit in any case of compound stresses if the stress in one direction is 30,000 pounds and regardless of the existence of lesser stresses, whether tension or compression, in directions at right angles. The formula attributed to Lamé for a thick tube or gun is an example of the application of the maximum stress theory.

Maximum Shear Theory

As a result of some brilliant experiments published in the *Philosophical Magazine*, May, 1900, Mr. J. J. Guest formulated the maximum shear theory. This publication formed an epoch in this subject, and the paper will undoubtedly go down in history as a classic. Mohr, in Germany, reached similar conclusions at about the same time, his publication being in the *Zeitschrift des Vereines deutscher Ingenieure* in January and November, 1900. Since this time, many explanations and discussions have been published on this subject in Great Britain.*

This theory states that the cause of an elastic limit and the criterion for the beginning of failure is the sliding of particles past each other due to shear, and that failure in ductile materials is due to this sliding and not to direct tension. Hence, any case of direct tension or compression produces a tendency to slide and the failure is due to this. A compression failure illustrates this directly. A tension failure if carefully examined will show the same point. It was also known for many years before Guest's publication that at about the time the elastic limit was reached in a tension specimen, lines at an angle of 45 degrees began to appear. It has been shown that this is the indication of failure by shear. The evidence presented by investigators seems to the writer conclusive that this theory must be adopted to the exclusion of the maximum strain and maximum stress theories. It shows that failure by tension and failure by compression are really only different aspects of failure by shear. Failure means the beginning of sliding which is not recovered when the stress is removed and gives permanent set, thus indicating the "elastic limit." It follows, therefore, that the elastic limit will be the same for tension as for compression. This is true for steel and other ductile materials and is in itself a point of evidence in favor of the maximum shear theory.

Cast iron has no elastic limit and the actions referred to do not occur, so that elastic failure does not exist in cast iron as called for by the maximum shear theory. As is well known, the action of cast iron is quite different in tension and compression. Some experimental work on cast iron indicates that rupture with compound stresses occurs when the maximum stress reaches the value causing rupture with simple tension. This, of course, may not mean that a safe compound stress with cast iron occurs when the maximum stress reaches the safe value for tension.

As an example of computation of equivalent simple stress by the maximum shear theory we will take the case of Fig. 3, supposing equal tension and compression stresses of 20,000 pounds per square inch. The equivalent simple stress is 40,000 pounds per square inch. This may be compared with the equivalent simple stresses by the maximum stress and strain theories, respectively, which are 20,000 and 26,000 pounds per square inch. In the case of Fig. 4, the maximum shear theory gives as the equivalent simple stress 20,000 pounds per square inch, and the maximum stress and strain theories give 20,000 and 14,000 pounds per square inch, respectively.

According to the maximum shear theory, a body compressed equally in three directions at once will never fail, no matter how great the stress, since the shear is zero. Some experiments seem to indicate the accuracy of this theory, and the inaccuracy of the maximum stress or strain theories, which call for failure with stresses equal to, and 2½ times, the elastic limit, respectively.

Use of Maximum Shear Theory

From the discussion above of computation of shear, the following rules for computation of the simple stress equivalent to any case of compound stresses follow directly, and these rules should be used in determining failure according to the maximum shear theory. When there are stresses in two directions at right angles, with no stress in the third direction, and with both stresses of the same kind, that is, both compression or both tension, the equivalent simple stress is equal to the greater of the two stresses. In this case the maximum stress theory gives exactly the same results.

When there are stresses in two directions at right angles, with no stress in the third direction, and with the stresses of opposite kinds, that is, one tension and one compression, the sum of the numbers giving the two stresses gives the equivalent simple stress. That is to say, if we have tension of 10,000 pounds in one direction and compression of 5000 pounds in another direction, the situation so far as failure is concerned is exactly the same as if we had a simple stress in a testing machine of 15,000 pounds per square inch.

When there are stresses in all three directions at the same time and all of the same kind, that is, all tension or all compression, we subtract the minimum from the maximum of the three stresses to obtain the equivalent simple stress.

When there are stresses in three directions at the same time, one or more tension and one or more compression, the sum of the numbers giving maximum compression and maximum tension stress gives the greatest equivalent simple stress.

In the case of a beam at the point of maximum stress there is usually stress in a single direction, so that this stress is a simple one and we need make no use of the maximum shear theory. In case of a rotating shaft subject to bending and twisting at the same time, that bending moment which, if existing alone, would give the same conditions so far as failure is concerned, is the square root of the sum of the squares of the actual bending and twisting moments. This is also equal to that twisting moment which, if existing alone, would give the same conditions so far as failure is concerned. In the case of a rotating wheel, such as a turbine disk, there are radial and tangential stresses which are both tensile stresses. Hence, the greater of the two gives the equivalent simple stress, the same as if the maximum stress theory were used. For the case of a thick tube or cannon with

* See "Engineering," July 10, August 21, September 4, October 23, November 6, November 13, November 20, and November 27, 1908; February 5 and August 20, 1909; December 15 and December 29, 1910; "Report of the British Association," Section G, 1913; "Philosophical Magazine," July and December, 1906; "Proceedings of the Physical Society of London," Volume 20; "Proceedings of the Royal Society," Volume 49.

internal fluid pressure P, and ratio of outside to inside diameter R, the maximum equivalent simple stress is

$$\frac{2PR^2}{R^2-1}$$

If a hub is pressed on a solid shaft of the same material, the original difference in diameters being Y inch per inch of bore, with modulus of elasticity E, the maximum equivalent simple stress is EY.

* * *

WORK-HOLDING FIXTURES FOR THE VERTICAL SURFACE GRINDER

The Ritter Dental Mfg. Co. of Rochester, N. Y., makes extensive use of the vertical surface grinder for machining operations in the factory. Some of the work done is quite unusual, yet with the fixtures which have been provided the vertical surface method of finish-grinding has worked out well.

Fig. 1 shows an installation of the Blanchard vertical surface grinder in the shop, and the operator is shown surface-grinding the halves of ball-and-socket joint sections for the Ritter dental engine. These pieces, which are drop-forgings, are held by catching the front ends in V-blocks at the central part of the fixture, while the outer ends are clamped by the hand clamps seen in front of each piece. These act on simple levers, clamping the pieces inward and downward at the same time. After the forgings are located, it is an easy matter to grind them to an even bearing surface, the finish of which is much better than could be obtained by ordinary milling methods. Especially is grinding advantageous as the scale due to the drop-forging operation is difficult to mill.

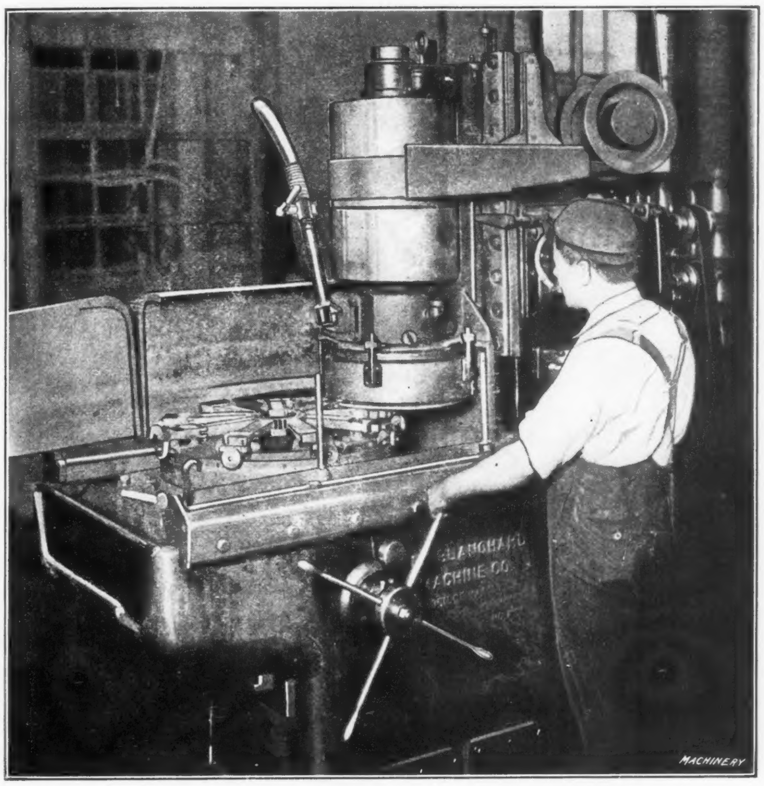


Fig. 1. Facing Forgings on a Vertical Surface Grinder

In Fig. 2 are shown six other grinding fixtures used upon the vertical surface grinder. At A is a fixture for holding small sections of extruded brass. Because of the fact that this metal is extruded, the outlines are all exactly alike; therefore they can be held by the pin method as shown. The pins are located so that several different sizes may be held on the same fixture. In the illustration only a few of the parts to be ground are shown in place, but these are sufficient to illustrate the principle involved.

At B is an unusual fixture for a surface grinder. On this plate there are provisions for holding ten engine castings so that the ends of the cylinders may be faced off. The castings are located with four pins each and are clamped at the sides to hold them firmly down against the fixture.

At C is shown the only magnetic fixture in this lot. This is for holding small thin disks. The disks are made of steel and are grouped in the channels provided on the plate. After one side has been faced off they are turned over and similarly treated on the other side.

At D is shown a fixture for holding the engine bodies in inclined positions for facing off the section which may be seen in the vertical plane on the casting shown on the fixture. This fixture provides for holding six castings, and the method is the best and quickest way of finishing this surface on the casting.

A similar fixture is shown at E. This, however, provides for holding the cylinder castings in a reverse position from that shown in the fixture at D, and is for the purpose of grinding the bases. Ten of the castings are held on this fixture, being bolted with straps between each two pieces.

The fixture shown at F is also for holding extruded brass sections, being of the same design as the fixture illustrated at A. Here, again, a few of the sections are shown in place, only enough being shown to illustrate the principle. C. L. L.

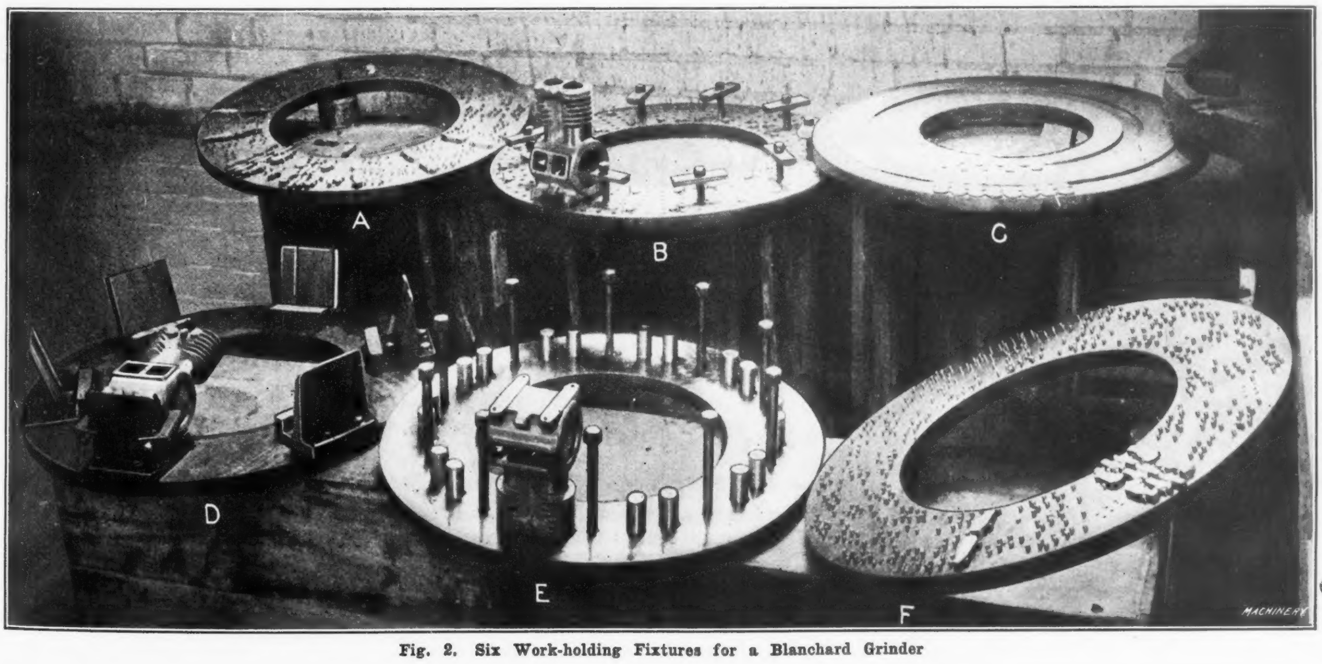


Fig. 2. Six Work-holding Fixtures for a Blanchard Grinder

SOME RECENT IMPROVEMENTS IN CASEHARDENING PRACTICE*

MATERIALS USED FOR CARBURIZING—ACTION OF DIFFERENT MATERIALS—MEANS OF CONTROLLING HEATING FURNACES AND MEASURING HARDNESS OF WORK

THE experiments in casehardening practice referred to in the following were for investigating the materials used for carburizing, the action of different materials, and the means of controlling the heating furnaces, and of measuring the resultant hardness of the work. The experiments began at the furnace end of the problem. At first it was decided to install pyrometers, but this was not done, owing to the high cost of an efficient pyrometric outfit for a battery of thirteen muffles; moreover, it was thought that such an outfit might be too expensive to keep in working order. There was also doubt as to whether thermo-electric and resistance pyrometers would be suitable for a system starting with a hot furnace full of cold work or for ascertaining the temperature of an isolated article.

Optical Pyrometers

Finally, after considerable experimenting, an optical form of pyrometer was adopted containing a dye solution capable of absorbing the rays emitted by the hot steel at various temperatures. Front and rear views of one of these pyrometers are shown in Fig. 1. It has an eye-shield to guard the eyes from extraneous light, and instead of two lenses, there are two pairs of dye solutions well protected by caps which also serve to keep out the light. This form is suitable when some particular temperature is required. For instance, the casehardening temperature is controlled by means of an instrument like this, having one pair of cells containing dye solution adjusted to 900 degrees C. and another pair adjusted to 925 degrees C. If the pots containing the parts to be casehardened are visible through the 900-degree pair and invisible through the 925-degree pair, the temperature is considered correct. There is no need to remove the eyes while the pairs are being changed, as the aluminum carrier can be shifted from one side to the other.

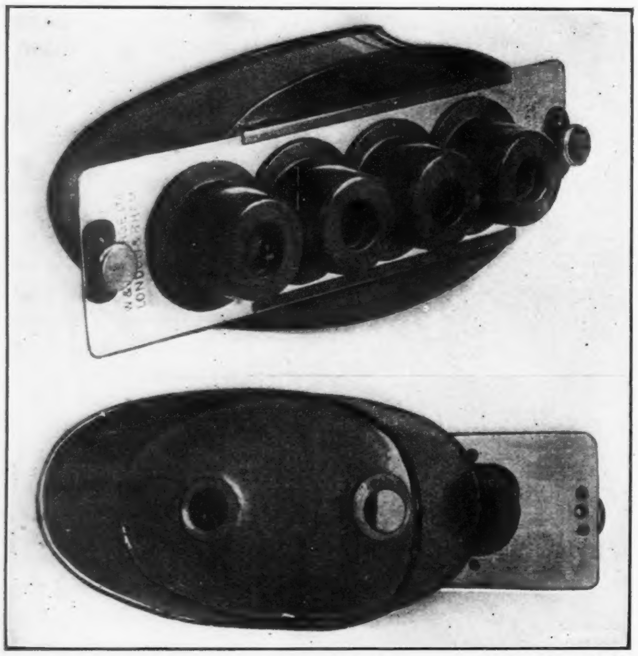


Fig. 1. Front and Rear Views of an Optical Pyrometer having Two Pairs of Cells containing Dye Solution through which Heated Work is observed

For reheating work, and for hardening tools, a single pair is all that is necessary. The hardening temperature is attained as soon as the work appears just visibly red. For double reheating two pairs are, of course, necessary. The cells can be interchanged and are readily detachable, so one instrument can be used to ascertain any temperature, provided the object be visibly red hot. The actual container is a glass tube less than one inch long, with accurately fitting glass ends held together on rubber rings by two telescoping brass tubes. In form, the cell is much like a short polarimeter tube. The caps on the aluminum slides are provided with springs to prevent the cells from falling out.

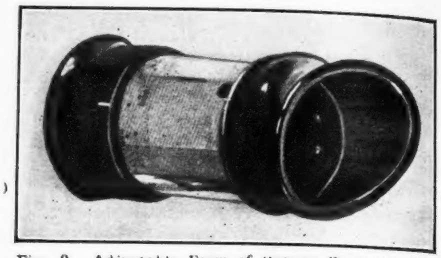


Fig. 2. Adjustable Form of Optical Pyrometer for Temperatures over 400 Degrees C.

In another form the instrument is adjustable and is either monocular or binocular. The dye solution is contained in expansible cells, and a range of absorptive powers is obtained by altering the length of the column. The first pyrometer of this form was made with two thick glass ends and a length of inner tube from a bicycle tire. On squeezing the glass ends together, the rubber sides bulge outward. This is an example of the present form seen in Fig. 2. The actual container is enclosed in the tube, which is provided at one end with an eye-piece, and at the other with a screw which serves to lengthen the cell until the added part is sufficient to just absorb the light. The temperature is indicated by a scale engraved on the tube. This form of pyrometer is perhaps not quite so accurate as the form with each cell specially made to one temperature. According to a National Physical Laboratory report the error may be ± 10 degrees C. The form shown in Fig. 2 is three inches long by one and one-half inch diameter and is very convenient to use.

The method of determining temperatures is a zero method and is, therefore, more accurate than one involving a comparison of colors; furthermore, the critical point occurs when the eye is shaded from extraneous light, that is, when the pupil is dilated and the retina is in its most sensitive condition. In judging temperatures by the unaided eye errors are caused by (1) extraneous light falling on the eye; (2) the difficulty of remembering close shades of color; (3) errors of judgment in comparing the image of the color observed with a series of mental images of colors previously seen.

All these chances of error are eliminated by an instrument of the kind shown in Figs. 1 and 2. No extraneous light falls on the eyes and no recollection is required; the hardener has simply to look through, wait about half a minute until his eyes have become accustomed to the darkness, and then see whether the object is visible as a dark red patch or invisible. Hardeners seem to prefer to use their eyes for telling the temperature, and these instruments provide pyrometric equivalents for limit gages and micrometers, and at the same time screen the eyes from the

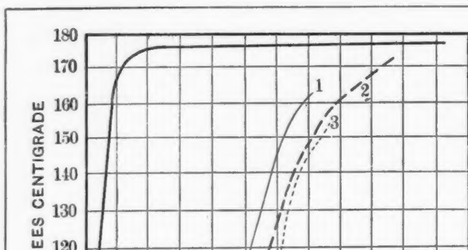


Fig. 3. Curves showing Rise of Temperature in Casehardening Pots filled with Granular Charcoal of Various Sizes containing 6 Per Cent Moisture

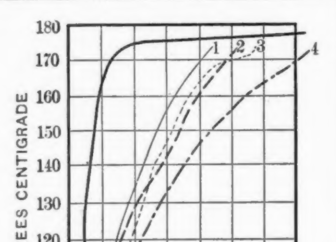


Fig. 4. Rise of Temperature of Dry Charcoal of Various Sizes—compare with Fig. 3

* Abstract of a paper presented before the Iron and Steel Institute, London, by Henry L. Heathcote.

glare and heat of the furnace. The readings are admittedly dependent on the sensitiveness of the eye; if this varies with different workmen, the temperature readings will vary accordingly, being lower the more sensitive the eye. These variations, however, do not greatly affect the accuracy, and from actual experiments it is believed that the variation in sensitiveness, under the actual working conditions of these instruments, is not nearly so great as might be expected.

If the object be a large one, it is advisable to interpose a perforated screen between it and the instrument. One way to make an observation is to adjust the instrument to a lower

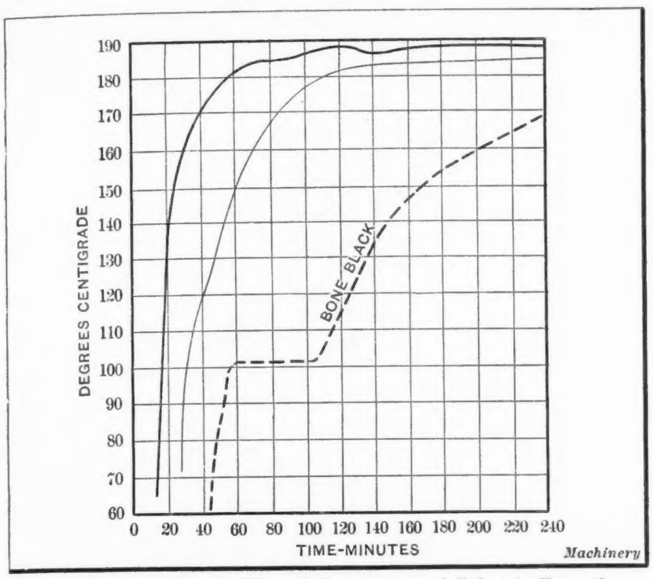


Fig. 5. Comparison in Rise of Temperature of Soda-ash Charcoal Mixture and Bone-black Bone-dust Mixture

temperature than that expected, and then, by sliding darker cells into position, or by unscrewing (if of the adjustable form), darken the image until it just ceases to appear colored. The temperatures engraved on the cell or the body of the instrument will then indicate the temperature of the hot body, provided the conditions of the test are as nearly "black body" as those obtaining when the calibration was effected. These instruments have been applied with satisfactory results to the heat-treatment of steel, carburizing, reheating, annealing, and hardening tools of all kinds.

Casehardening Composition

Having provided a simple and effective device for ascertaining the temperature of red-hot bodies, the nature, mode of action, and effect of casehardening compositions were next investigated. Obviously for carburizing to occur (1) the heat must first penetrate to the steel and raise it to the proper condition; (2) it must liberate and maintain a supply of the carburizing ingredients; (3) the peripheral layers of the steel must combine with (or dissolve) these ingredients; (4) the carbide must diffuse from the periphery inward.

The composition of casehardening materials varies very widely. The following table shows the range of variation in seventeen commercial compositions tested:

TABLE I. VARIATION IN CASEHARDENING COMPOSITIONS

	Per Cent
Moisture	2.68 to 26.17
Oil	0.17 to 20.76
Carbon (organic)	6.7 to 54.19
Calcium phosphate	0.32 to 74.75
Calcium carbonate	1.2 to 11.57
Barium carbonate	nil to 42.0
Zinc oxide	nil to 14.5
Silica	nil to 8.14
Sulphates (SO_3)	trace to 3.45
Sodium chloride	nil to 7.88
Sodium carbonate	nil to 40.0
Sulphides (S)	nil to 2.8

When these experiments were begun the mixture of barium carbonate, 40 per cent, and charcoal, 60 per cent, suggested by Guillet was not in use, and it was usual to use casehardening compositions once only or perhaps twice. Another drawback experienced in commercial operation, for instance, with pots ten inches high by ten inches in diameter, was the difference in the depth of penetration near the middle and the outside of the pot. Some compositions showed as much as 150 degrees C. difference in temperature between the inside and the outside. The author accordingly set out to improve: *Permanence*, and to obviate loss of activity and consequent wastefulness; *permeability* to heat, and to obviate unequal heating and casing.

The supposition that the loss of carburizing power was due to loss of nitrogenous constituents was confirmed by early experiments. Spent hardening mixture may contain 12 per cent organic carbon (total carbon less carbon in carbonates), and yet, under similar conditions, have far less carburizing power than fresh material containing less carbon. Such spent mixture gives indication of only traces of nitrogen.

Experiments extending over a considerable time and range of composition have confirmed the following suppositions: (1) the depth of case depends chiefly on the temperature the steel attains and the duration of the hot condition. On these factors depend the rate and extent of the diffusion of the carbon or carbide. (2) The concentration of the carbon in the case depends chiefly on the "activity" of the mixture, or rate at which it or its products part with carbon to the steel. The concentration of carbon in the surface layers may increase or decrease with temperature, but usually increases as the temperature rises and with the time. (3) The duration of the hot condition for a given time of heating depends chiefly upon the permeability to heat of the casehardening composition.

Comparative depth of penetration has been the subject of a number of investigations, but is so much dependent on factors other than the casehardening composition that the author has sought for some other test. The one finally adopted is to take a known volume of the composition and ascertain the volume of the "case" that can be obtained from it without replenishing.

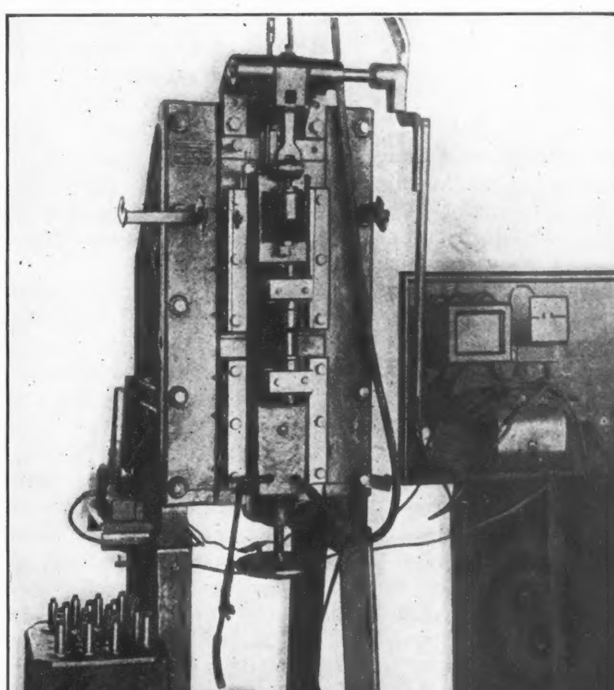


Fig. 6. Electric Welder, arranged for tempering Casehardened Articles

The ratio of total volume of case to initial volume of casehardening material affords a good indication of the efficiency of the composition, and is not so dependent as a single penetration measurement on other factors such as size of pot, number and size of the articles it contains, loss of heat from furnace walls when the pot is introduced, etc.

The results of testing some experimental mixtures showed that wood charcoal impregnated with soda ash gave a ratio of 0.116. This mixture is eminently suitable on the score of

permanence, and can be used over and over again indefinitely, provided that the inevitable waste involved in commercial usage is made up from time to time with fresh composition and that the ingredients are well incorporated and in the proper proportions.

Permeability to Heat

Having found a composition far more permanent in its properties than any then in current use, the author proceeded to investigate the factors concerned in permeability to heat. Most commercial mixtures consist of or contain a large proportion of small particles which it seems reasonable to expect will block up all the interstices and prevent the free passage of heat, for it has been shown that the heat conductivity of insulating materials depends chiefly on their

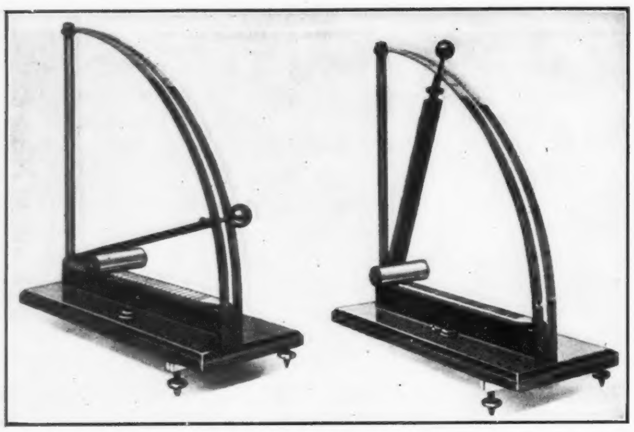


Fig. 7. Quadrant Sclerometer for testing Hard and Soft Bars—Two-file Form

air spaces. To test this point, granular charcoal was employed, and two model casehardening pots, 5 inches high, 3.7 inches in diameter and 0.04 inch thick, were made of sheet steel and welded together. One contained the charcoal under investigation, and the other was used empty. A thermometer bulb was placed at the center of each pot and the apparatus placed in an oven at 180 degrees C. Fig. 3 shows the rise of temperature with time. The curve on the left shows the temperature at the middle of the empty pot; those on the right, numbered 1, 2, 3, 4, refer to charcoal of various sizes, each containing approximately the same proportion of moisture and taken from the same sack.

Two striking points are brought out by these results: First, the arrest of temperature at the center at about 100 degrees C. while moisture is being driven off; and second, the effect of size of grain and particularly of dust upon the duration of the arrest. When the same samples were again heated the temperature rose much more quickly (see Fig. 4). The absence of any arrest is, of course, due to the moisture having been expelled during the previous tests.

A mixture which can be used over and over again possesses the great advantage that moisture, oil and other volatile constituents have, for the most part, been already expelled by the previous heatings. This is illustrated by the results plotted in Fig. 5. The curve on the right refers to a mixture of bone-black and bone-dust; and the middle one to the soda ash and charcoal mixture (consisting of three parts used to one part not used) freed from all small particles and dust by means of a sieve with round holes 0.08 inch in diameter. The two mixtures were heated at the same time. The curve on the left shows the rise in temperature of a similar empty pot.

To see if these results represented anything of commercial importance, some tests were made with pots ten inches high by ten inches in diameter, with coarse and fine mixtures having the same composition. The same number and kind of articles were packed in each pot, and test-pieces, 1½ inch by ½ inch square, were placed near the top and bottom and at the middle of the pot. The pots were then heated together for five hours, the maximum temperature being about 925 degrees C. These test-pieces were reheated to 760 degrees C. and quenched in water to show the depth of the case. The following table represents the results:

TABLE II. COMPARATIVE DEPTHS OF CASE WITH FINE AND COARSE MIXTURES

	Top	Middle	Bottom
Fine	0.025" to 0.03"	0.02" to 0.025"	0.03" to 0.03"
Coarse as No. 3	0.045" to 0.05"	0.04" to 0.04"	0.045" to 0.05"

Composition of the Case

Having secured a considerable improvement in both permanence and permeability to heat, it remained to ascertain whether this composition imparted a suitable percentage of carbon and gave uniform results from day to day. W. T. Flather, who has made a great number of determinations of carbon in the successive layers of the case, carburized some bars of "Ubas" steel in his standard pot and under his standard conditions, but using the dust-free charcoal impregnated with soda ash (three parts used to one part fresh). The bars were ⅝ inch in diameter and 6 inches long, and were carburized four hours at 925 degrees C. Successive layers, 0.0025 inch thick, were turned off and the carbon content of each layer determined. The surface layer contained 1.050 per cent of carbon; the twentieth layer, 0.440 per cent; and the fortieth layer, 0.205 per cent. The even gradation of the carbon content from surface to core was noteworthy.

In a test on a commercial scale, extending over twenty-nine days, test-bars one inch in diameter were carburized along with ordinary work at 900 degrees to 925 degrees C., the mixture being replenished once or twice a week to make good the inevitable waste. The bars were cooled in the pots, and the surface layer turned off and analyzed. The results follow:

New mixture	0.967 per cent carbon
End of first day	0.909 per cent carbon
End of fourth day	0.981 per cent carbon
End of twenty-ninth day	1.06 per cent carbon

The author considers 0.9 to 1.1 carbon satisfactory, and preferable to less than 0.9 per cent. The cementite does not appear to form laminæ unless the percentage of carbon is greater than 1.05; and for work that has to be ground a slight degree of supersaturation at the surface is considered necessary. Charred leather at 1000 degrees C. imparts about 1.3 per cent carbon; at 925 degrees C. about 1.2 per cent carbon; and Guillet's composition(barium carbonate, 40 per cent; wood charcoal, 60 per cent) at 925 degrees C. about 1.2 per cent.

These analyses disclose the average carbon content of the layer in question, but they do not give any evidence of uniformity. It is quite possible that a composition having large grains may produce local inequalities in the degree of carburization. To test this point, the author has

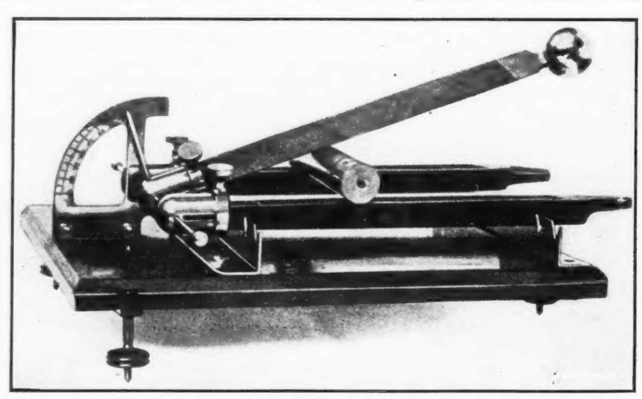


Fig. 8. Quadrant Sclerometer of Adjustable Three-file Form

employed the coloring solution, also the scleroscope and sclerometer referred to later. Even when the case on 1-inch bars of "Ubas" steel was not more than 0.012 inch deep, the color developed showed no indication whatever of local paucity of carbon. These bars were carburized in mixture made with grains of charcoal which would not pass through a sieve having five meshes per linear inch, and the bars were uniformly hard all over, even after grinding off the outside layers of the shallow case. On account of the low specific gravity of the composition and its comparative freedom from dust, oil and moisture, the heating-up period is a smaller proportion of the total time, so less judgment is

required in allowing for the size of pots, etc. The productive capacity of the hardening plant and staff is correspondingly increased, and the steel too is all the better for the shorter heating.

An Improvement in Tempering

The use of hot tallow and lead for tempering is, of course, well known; but the application of an electric welder, which, the author believes, was originated by V. A. Holroyd, presents some novel and advantageous features. Fig. 6 shows an electric welder arranged for tempering casehardened articles. It is particularly useful for local softening or tempering, and, unlike tempering in tallow, the core of the article is left softer than the outside. This is especially advantageous for casehardened parts. The operation is a very quick one, and the surface is left quite clean.

Methods of Testing Hardness

So far as the author is aware, very little work has been done to provide commercial means for testing the suitability of casehardened articles. The practice of examining test-pieces carburized, heat-treated and hardened along with each batch is, of course, sound as far as it goes. The Shore scleroscope and Brinell test have their spheres of usefulness, but still the file is the instrument most used, and perhaps

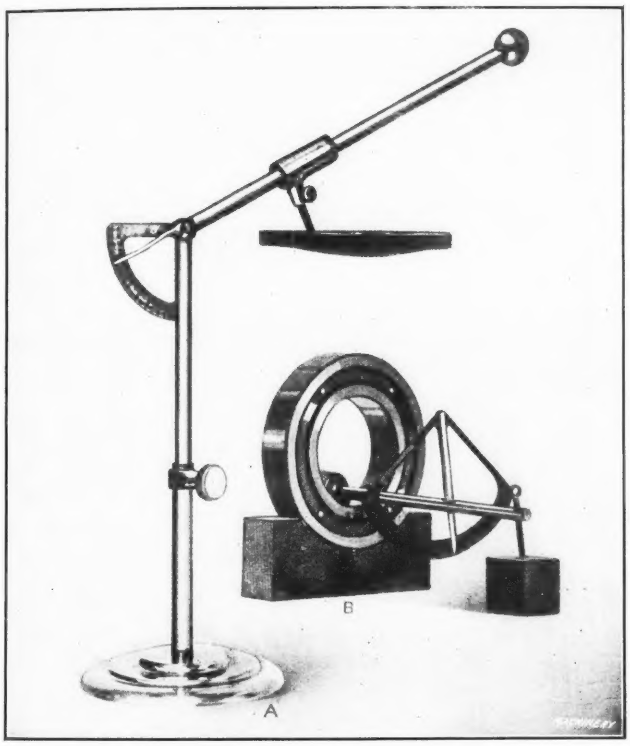


Fig. 9. (A) Quadrant Sclerometer for testing Flat Surfaces (B) Quadrant Sclerometer for testing Concave Surfaces

rightly, for it does give an idea of the resistance the surface of the article offers to abrasion under pressure, which is what most articles are casehardened to withstand. This and the Brinell test are, we believe, the instruments in commonest use for testing casehardened work and test-pieces.

For small articles a modified center punch is particularly suitable for rapidly getting a working idea as to whether the case is above the minimum permissible depth. An ordinary six-inch Brown & Sharpe automatic center punch is used. To the end has been fitted a screwed-on container for holding a 1/8-inch bicycle ball. The hard point has been removed and the container screwed on in its place. The ball protrudes just sufficiently to prevent the container from coming into contact with the article under test. This tool is very useful for large as well as small articles, and its readings appear to refer more to the case and less to the core than those obtained with a Brinell testing machine.

An Improved Sclerometer

On account of the variable element in testing resistance to abrasion with a file by hand, the author sought to devise means for measuring the friction under a given load. Small flat articles can be placed on the top of a file, and the hardness gaged by raising one end of the file and observing the angle when the article slides. This led to placing the article under the file so that its weight causes relative motion, which motion ceases (if not too rapid) when the frictional forces are great enough. The instrument shown in Fig. 7 is for testing round surfaces. A soft bar holds the top file up so that it makes an angle of about 70 degrees with the bottom one. A hard bar will not hold the file up until the angle falls to about 15 degrees to 20 degrees. The actual angle is indicated by figures engraved on the slotted quadrant. A hardened and tempered bar gives readings between these angles according to the degree of temper. Another form adapted to take larger articles is made with "three-cornered" files, so that the outer two can be moved further apart at will. This is shown in Fig. 8.

For concave surfaces, such as the ball races of motor-car bearings, a different type (seen at *B*, Fig. 9) is employed. The essential part of this is a short piece of round file which, with its two ends resting on the bearings, slides down one side or is deflected as the bearing is rotated. The angle taken up depends on the hardness and consequent friction, and is measured on a graduated quadrant. For flat surfaces, the instrument shown at *A*, Fig. 9, is used. A short file is mounted in a holder which slides along a smooth bar until friction arrests the motion.

That the quadrant sclerometer is very sensitive is shown by the way it detects slight degrees of tempering. Several are in regular use at both the Rudge-Whitworth Works, where they have to a large extent superseded the cruder hand test with ordinary files. They are handy and capable of dealing with large quantities of work in a short time. Instead of files, carborundum or alundum sticks or pencils may be employed, but files give very good results and last many months without showing any errors due to wear, provided they are properly made and appropriately aged before use. Various standards have been adopted for different articles, and the angle should come between the specified limits.

Production of Colors on Hardened Work

Many articles, such as cups and cones, cannot be conveniently tested with a scleroscope or sclerometer on account of their shape. Realizing the need for some method which would enable articles of all sorts to be tested in bulk, the author turned his attention to the production of colors on hardened surfaces which would afford an indication of the nature of the steel composing such surfaces. The ordinary solutions employed by the metallographer are unsuitable for commercial application; some because of their inflammability, others because they will not flow evenly over a somewhat oily or greasy surface. A suitable solution which has been found to give satisfactory results consists of alcohol, 1 liter; distilled water, 1 liter; nitric acid, pure, 100 cubic centimeters.

Articles ground or polished after hardening and immersed in this for one-quarter to one minute are stained brown or light blue where the structure is martensite; dark blue or dark grey where there is troostite; and hardly stained at all on ferrite or pearlite. By treating hardened articles in this way inequalities are rendered visible and can readily be detected. The fact that the whole of the surface is tested, and not merely the parts touched by the file, sclerometer or scleroscope is an enormous advantage for commercial purposes. The test reveals at once spots that have been splashed before quenching, also superficial tempering due to a glazed surface on the grinding wheel or to excessive pressure. It does not appear to be possible to obtain a colorimetric scale of hardness in this way, but when a number of articles are dipped at the same time, the eye readily detects those that have a different appearance and all that is then necessary is to check the odd ones with a file or sclerometer. This test is also suitable for tools and complicated articles that cannot conveniently be tested with an instrument. It also shows the depth of case if a part is left on and ground away, and should prove useful for ascertaining whether an article has been properly tempered or not.

A PLEA FOR ACCURATE PATTERNMAKING

A DISCUSSION OF THE RELATION BETWEEN THE PATTERN SHOP, FOUNDRY AND MACHINE SHOP

BY HARRY E. HARRIS*

There is probably no factor in machine shop work which causes more uncertainty than the accuracy of the work of the patternmaking department. Where only a few pieces are to be made, a little extra machine work required to correct the result of the patternmaker's lack of foresight or the molder's carelessness does not amount to much. But in the case of interchangeable manufacture on a large scale, where competition makes the price obtained for the work relatively low, it is safe to say that too great refinement in patternmaking is impossible. Proper construction of the pattern, making suitable allowances for coring, shrinkage, rapping and fitting of the core prints, are far more important factors in the cost of production than is generally realized.

The removal of fins frequently left around cored holes is quite an item of expense in the foundry and may be regarded as an indication that the cores were loose in the molds.

DECIMAL EQUIVALENTS OF AN INCH WITH CORRECTIONS FOR SHRINKAGE

Size	Decimal Equivalent	Shrinkage in Inches per Foot		Size	Decimal Equivalent	Shrinkage in Inches per Foot	
		1/8	3/16			1/8	3/16
1/64	0.01563	0.0158	0.0159	33/64	0.51563	0.5210	0.5237
1/32	0.03125	0.0316	0.0317	17/32	0.53125	0.5368	0.5396
3/64	0.04688	0.0474	0.0476	35/64	0.54688	0.5526	0.5555
1/16	0.0625	0.0632	0.0635	9/16	0.5625	0.5684	0.5713
5/64	0.07813	0.0789	0.0794	37/64	0.57813	0.5842	0.5872
3/32	0.09375	0.0947	0.0952	19/32	0.59375	0.5999	0.6031
7/64	0.10938	0.1105	0.1112	39/64	0.60938	0.6157	0.6189
1/8	0.125	0.1263	0.1270	5/8	0.625	0.6315	0.6348
9/64	0.14063	0.1421	0.1428	41/64	0.64063	0.6473	0.6507
5/32	0.15625	0.1579	0.1587	21/32	0.65625	0.6631	0.6665
11/64	0.17188	0.1737	0.1746	43/64	0.67188	0.6789	0.6824
3/16	0.1875	0.1895	0.1904	11/16	0.6875	0.6946	0.6983
13/64	0.20313	0.2053	0.2063	45/64	0.70313	0.7105	0.7142
7/32	0.21875	0.2210	0.2222	23/32	0.71875	0.7263	0.7300
15/64	0.23438	0.2368	0.2381	47/64	0.73438	0.7420	0.7459
1/4	0.250	0.2526	0.2539	3/4	0.750	0.7578	0.7618
17/64	0.26563	0.2684	0.2698	49/64	0.76563	0.7736	0.7776
9/32	0.28125	0.2841	0.2857	25/32	0.78125	0.7894	0.7935
19/64	0.29688	0.3000	0.3015	51/64	0.79688	0.8052	0.8094
5/16	0.3125	0.3158	0.3174	13/16	0.8125	0.8210	0.8252
21/64	0.32813	0.3316	0.3333	53/64	0.82813	0.8367	0.8411
11/32	0.34375	0.3474	0.3491	27/32	0.84375	0.8526	0.8570
23/64	0.35938	0.3631	0.3650	55/64	0.85938	0.8684	0.8729
3/8	0.375	0.3789	0.3809	7/8	0.875	0.8841	0.8887
25/64	0.39063	0.3947	0.3968	57/64	0.89063	0.8999	0.9046
13/32	0.40625	0.4105	0.4126	29/32	0.90625	0.9157	0.9205
27/64	0.42188	0.4263	0.4285	59/64	0.92188	0.9315	0.9363
7/16	0.4375	0.4421	0.4444	15/16	0.9375	0.9471	0.9522
29/64	0.45313	0.4579	0.4602	61/64	0.95313	0.9631	0.9681
15/32	0.46875	0.4736	0.4761	31/32	0.96875	0.9789	0.9839
31/64	0.48438	0.4894	0.4920	63/64	0.98438	0.9946	0.9998
1/2	0.500	0.5052	0.5078	1	1.00000	1.0104	1.0157

Machinery

Consequently, when the metal was poured, the cores shifted sufficiently to throw the cored holes off center. The result is that an excessive amount of metal must be allowed for finish so this error may be compensated for in the machining operation, and the removal of this metal often requires two or more cuts to be taken where a single cut might have sufficed. By keeping cored holes to their largest practicable diameter and as close to the central position as possible, the extra metal required and the consequent amount of work in machining is reduced to a minimum. In cases where the hole is to be used for a bearing, a further advantage is secured, owing to the fact that the metal is of much closer grain than it would be if a heavier chip was taken. This is but one instance of the observance of precautions in patternmaking which makes possible material savings in the cost of subsequent machining operations.

* Consulting Engineer, Greenfield Tap & Die Corporation, Greenfield, Mass.

In addition to the saving in machine work, a considerable economy is effected by the reduction in the amount of metal required for the castings. The writer has a case in mind where a certain lever had to have both hubs accurately finished so that they were exactly parallel to each other. This was originally done by leaving 1/16 inch of metal for finishing on each face of the hubs, the machining operation being performed expeditiously by straddle milling. Multiple fixtures were used in connection with high-speed steel cutters and one operator was able to look after three machines. Each of the machines was equipped with two fixtures which were arranged one on each side of the cutter arbor. Thus all three machines were cutting practically continuously, as it was possible for the finished work to be replaced by rough castings in one of the fixtures while the cutters were working on the four levers held in the fixture at the opposite end of the table.

By changing the pattern so that the amount of material to be removed in machining was greatly reduced, it was found possible to finish the faces of these hubs on a double-head disk grinder, and in six months' time the saving of metal and labor effected by this change was sufficient to pay for the new machine. The cost of manufacturing was not only reduced, but the quality of the work produced was better than that which it had been possible to secure by milling. The operator of the grinding machine could remove the few thousandths left on the faces of the hubs almost as fast as he could put the work between the disks and lay it down again. The laborious clamping, cost of cutter up-keep, and trouble with the cutters due to hard scale on the work was eliminated. It was merely necessary for the operator to put fresh abrasive disks on the wheels of his machine every night before going home; this required about fifteen minutes, while the changing of the disks during the day took approximately twenty minutes. In order to secure these advantages, it was necessary for the pattern to be accurately made with proper allowance for rapping and shrinkage. It was also necessary to insist upon good work from the molders. This was obtained by furnishing the foundry with an inexpensive snap gage for testing the castings. These castings were tested again when they reached the machine shop, and any of them which did not check up to the gage were returned and not paid for.

There are many other instances where the ends of hubs and other small surfaces on castings can be economically finished on the disk or surface grinding machine, if the allowance for finishing is reduced to a minimum. This means the saving of a great deal of time which would otherwise be required for planing, milling or facing such parts. The difficulty which lies in the way of taking advantage of these economies is not physical but rather psychological, owing to the fact that the molder does not know much about the use of gages or accurate work until the necessity for it is explained to him. When he once thoroughly grasps the idea, however, that he is to be supplied with accurate patterns and that he can do good work just as quickly as he formerly did inaccurate work, he will be glad to cooperate, particularly when it is explained to him that it will no longer be necessary to file cores and retouch patterns in order to obtain a good job. On the other hand, the demand for good patternmakers who really understand their business far exceeds the supply.

It is usually the case that half the work of the metal patternmaker in the average shop consists of changing the patterns after a run of castings has been made from them, in order to correct slight defects that the molder has managed to develop in the majority of the castings. After the patternmaker has added a little metal at this spot, removed some at other places and bent the pattern a little at certain points, he and his foreman feel satisfied that it is correct. It is more than likely, however, that the next run of castings will show errors, and if such is the case the patternmaker will undoubtedly get the blame. Although it is quite possible that he is not responsible for the error in the castings, he is to blame for not knowing enough about foundry work to know how these errors were developed in castings made from pat-

terns that he knew were accurate. It is quite possible by proper cooperation between the foundry and machine shop, and between the molder and the patternmaker to secure results in the way of economy that should not be overlooked by the management of any progressive plant. It is not claimed that it is always possible to make a pattern the first time so that the castings will leave nothing to be desired; but any necessary changes and corrections should be accurately and intelligently made after conducting a careful study of the conditions which necessitate such modifications.

The writer has intimate knowledge of conditions in a certain firm engaged in the manufacture of relatively small parts, where all allowances and dimensions are figured out by the engineering department, after it had conducted a careful investigation. For instance, with fine sand for light work it was found that the minimum fillet to be allowed on any inside corner must be at least 0.020 inch. A coarser sand would naturally require a larger fillet and *vice versa*. Sharp corners had to be rounded to a corresponding degree. The observance of these directions was found to aid the molders to produce good clean molds. In order to prevent the formation of fins, it was necessary for the cores to be an accurate fit in the core prints in the mold. A print on the pattern made the same size as the core box would not give this result, as the rapping of the pattern and the shrinkage of the cores would be responsible for a serious inaccuracy. To illustrate, it was found that a core print 1 inch in diameter on the pattern enlarged the print in the mold approximately 0.012 inch, due to rapping; and that when the cores were baked, they shrunk 0.008 inch. Thus it is obvious that the metal core box should be made 0.008 inch larger than the desired size of the cored hole, and that the prints on the patterns should be 0.012 inch smaller. Where the print joins the body of the pattern, a 0.020 inch fillet should be provided. Patterns were made according to these specifications and the molders were very much pleased after they had used them.

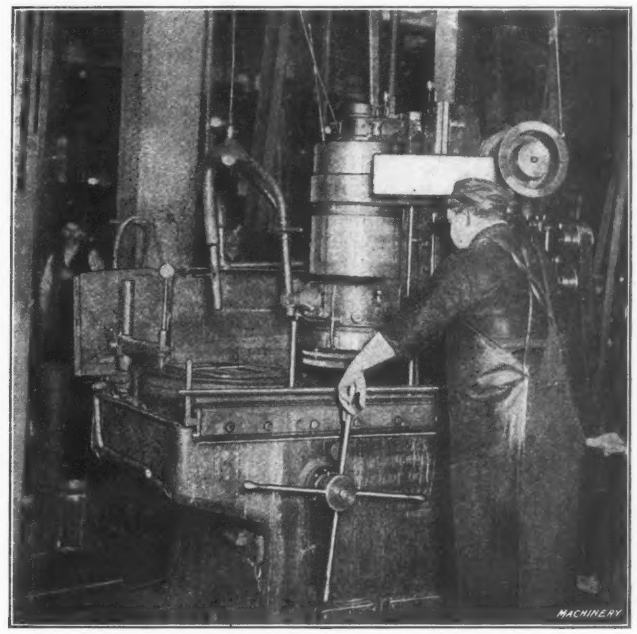
As this method was used on all of the regular manufacturing work done by this company, there was a good deal of calculation to be performed to determine the shrinkage in different cases. To simplify this work, a table of shrinkages was figured out. This table is the means of saving a great deal of mathematical work in determining shrinkage to 0.0001 inch, and it is also the means of avoiding errors in calculation. It is presented herewith in the hope that it may be of value to other readers of MACHINERY. As metal patterns become more generally used, it is possible that micrometers and vernier scales giving readings of over-size dimensions may be developed which are made for use as shrink rules. In this way, dimensions could be taken direct from the work or drawing, instead of requiring to be re-figured to provide for shrinkage.

By way of conclusion, it may not be out of place to say a few words in regard to the composition of metal patterns and core boxes. A long series of experiments in the foundry of the company previously referred to, showed that the cast-iron patterns and core boxes which have rusted on the surface and been subsequently treated with beeswax, were capable of producing the greatest number of castings with the minimum amount of trouble. Brass and white metal patterns and core boxes appeared to get greasy and sticky, and a further disadvantage was due to the fact that they were heavier and more easily bent. Experience has also shown that they are not so easily withdrawn from a sand mold. The chief advantage of brass for use in making metal patterns is the ease with which an error can be corrected or changes made by adding solder patches. White metal is inexpensive and patterns may be quickly made from it for handling "hurry jobs;" but neither of these metals is as durable as iron or steel. They lose their shape and accuracy quite quickly, due to the abrasive action of the sand, and many cases are on record where large quantities of castings have had to be discarded because they were under size, the cause being finally traced to the wear developed in brass or white metal patterns. If properly rusted and waxed, however, cast-iron patterns will last almost forever. They should be re-waxed occasionally, this being done by simply warming them, rubbing the wax over the surface and then rubbing the surface off before the patterns get cold, in order to remove the excess wax.

* * *

HOLDING COPPER ON A MAGNETIC CHUCK

We all know that copper is not magnetic and could not ordinarily be held on a magnetic chuck. Yet in the accompanying illustration is shown the method that the Pierce-Arrow Motor Car Co. of Buffalo, N. Y., employs in holding copper pans on the magnetic chuck of a vertical surface grinder. The grinding operation on the pans consists in facing off the upturned edges to the finished height. The



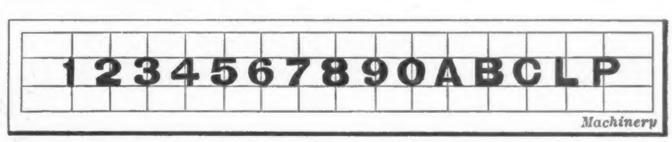
Grinding Copper Radiator Ends on a Blanchard Grinder

metal of the pans is about 1/16 inch thick, and the flange is turned up for a distance of approximately ½ inch. Therefore, in order to hold these pans to the magnetic chuck, steel plates are placed inside the pan, through which the magnetic chuck acts, pulling the blocks and consequently the pan down to the chuck. This is a good method of holding these pieces and the grinding operation is performed without difficulty. C. L. L.

* * *

METHOD OF NUMBERING DRAWINGS

The accompanying illustration shows a method for rapidly placing the drawing numbers on drawings. A small slip of tracing cloth is provided with figures and letters as shown. When the drawing number and symbols for a drawing are to



Figures and Letters on Piece of Tracing Cloth used as a Guide in placing Numbers on Drawings

be printed on it, it is only necessary to slip this piece of tracing cloth underneath the tracing, and copy off the required letters and figures free-hand. In the case shown, only five letters were used in addition to figures to designate the drawing numbers. The whole alphabet, of course, could be treated in the same manner. The vertical and horizontal lines drawn help to locate the piece of tracing cloth in the right position beneath the tracing when numbers consisting of several figures are to be printed.

* * *

An endowment of $2000 has been received by the American Society of Mechanical Engineers from Henry Hess, one of its members, the income from which is to be used for prizes for technical papers prepared by junior and student members.

LOBDELL CALENDER ROLL GRINDING MACHINE

DETAILS OF AN INGENIOUS FORM GRINDING MECHANISM USED IN CROWNING THE TOP AND BOTTOM ROLLS OF A SET

THE manufacture of paper requires some of the most ponderous and costly machinery used in any line of manufacture. A continuous paper-making machine of the Fourdrinier type is perhaps 80 to 90 feet long, beginning at the breast box, from which the pulp is deposited on the endless wire screen belt, and ending with the finished roll of paper. The machine is divided into two parts known as the wet and dry ends, respectively. The wet end includes the stuff box, sand table, strainer, breast box, deckel straps, dandy roll, couch rolls, endless felt belts, first-press rolls and second-press rolls. The dry end, as the name implies, dries the wet paper web by passing it over massive drying cylinders, thence to the nip rolls and over more drying cylinders, and finally to the calender rolls which give it uniform thickness, hardness and surface finish.

The great size and weight of the calender rolls, of which there may be two or three stacks, are astonishing to one unfamiliar with paper making. The illustration Fig. 1 shows a stack composed of twelve rolls, the total weight of which is over 40,000 pounds. This stack is a baby, however, compared to some that have been made. Rolls 200 inches long and 30 inches in diameter have been made for some of the largest paper-making machines. Now, when it is taken into account that these rolls must be as hard as the traditional "hub of Hades" and perfectly round and highly polished, the problem of production seems sufficiently difficult, but when, in addition, it is considered that the bottom and top rolls have to be ground large in the middle, tapering to the ends, in order to compensate for deflection, the problem becomes still more difficult. But like many other tasks which appear very difficult to the layman, it is handled with precision and certainty in several plants in the United States that make a specialty of grinding calender rolls.

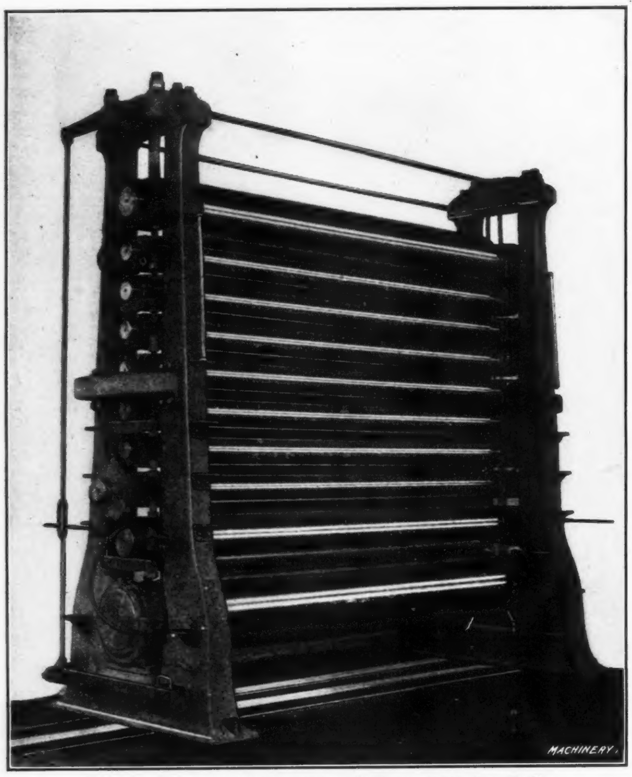


Fig. 1. Stack of Twelve Ground Paper Calender Rolls

The Lobdell roll grinding machine of the electrically-driven type, made by the Lobdell Car Wheel Co., Wilmington, Del., is shown in Fig. 2. This machine is built in three sizes, the smallest having capacity for rolls up to 18 inches diameter, and the largest, for rolls up to 30 inches diameter. The length of calender rolls varies, a not uncommon length being about 100 inches. Some of the rolls are hollow for steam coils, but as many are solid castings it is evident that the machine must be of massive construction to support the great weight of the roll. The largest size machine has a bed 23 feet 6 inches long and weighs 30,000 pounds.

The rolls are supported on their journals by V-blocks which are adjustable on the bed for various lengths. The V-blocks have been found best for this work, inasmuch as the journal automatically centers itself and requires no lateral adjustment. Two grinding wheels are provided, one on each side of the roll. The wheels are each driven by two belts. The spindle bearings are a plain taper and are supported in phosphor-bronze bearings, a construction peculiar to the Lobdell roll grinding machine and the result of many years' experience with this peculiar type of grinding. Calender rolls must be ground with great accuracy and to the utmost smoothness, and the metal is dense chilled cast iron. The grinding wheels are mounted on a carriage, and in the case of the motor-driven machine the carriage also carries the motors overhead. In the case of the belt-driven machines, two overhead drums are provided of a length equal to the longest traverse required.

The grinding wheels are mounted on opposite sides of the roll and the thrusts of the wheels against the roll are bal-

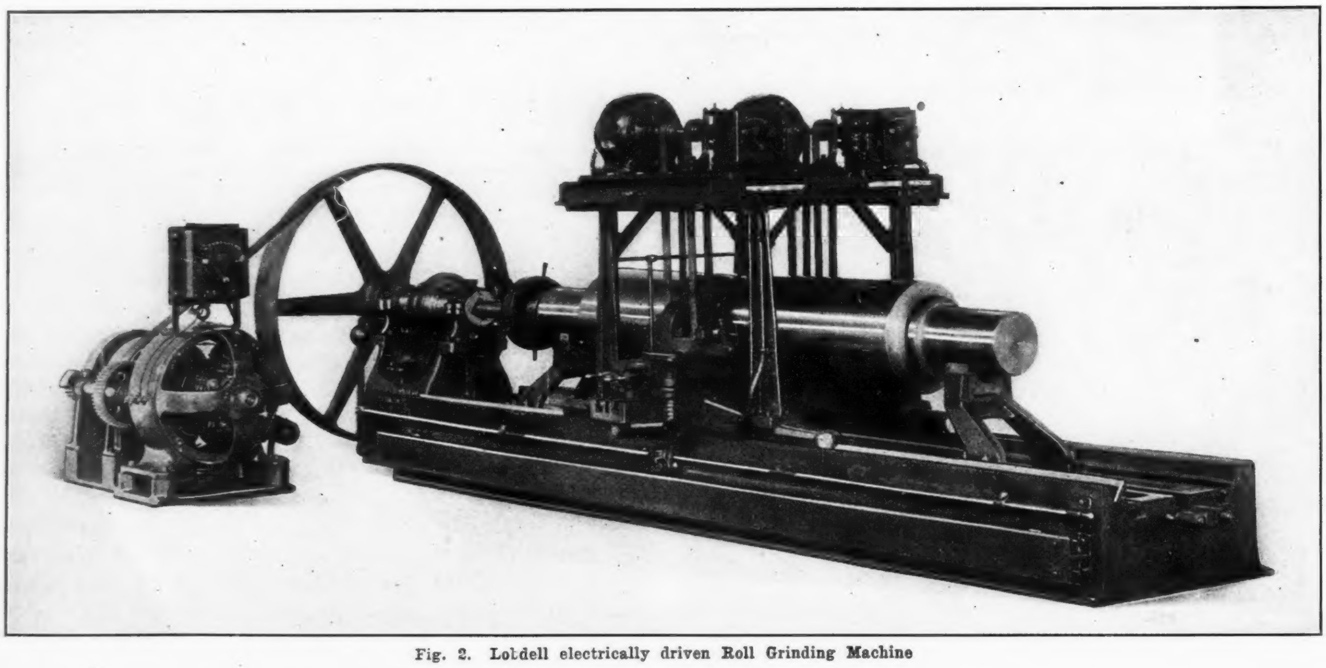


Fig. 2. Lobdell electrically driven Roll Grinding Machine

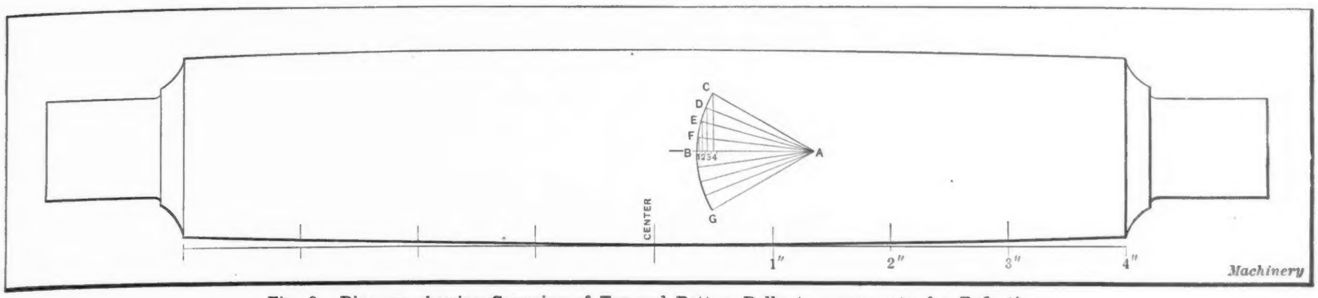


Fig. 3. Diagram showing Crowning of Top and Bottom Rolls to compensate for Deflection

anced. The wheels are comparatively narrow, the usual width being about 1½ inch, and the feed of the carriage is somewhat less than the wheel width, of course, as is usual in all cylindrical grinding operations. The roll is flooded during grinding.

As will be noted in Fig. 1, a stack of calender rolls is erected so that the entire weight is carried on the bottom roll. Besides this, additional load is imposed by weights acting through a system of multiplying levers. The effect of the superimposed load, which may amount to 50,000 pounds, is to deflect both the top and the bottom rolls an appreciable amount. To compensate for this deflection, both the top and the bottom rolls must be ground with a "crown," that is, larger in the center than at the ends. The amount of crown varies with the diameter and length of roll, being 0.010 inch in the case of 16-inch rolls, 116 inches long.

It is evident that an ordinary former or guide for producing the crown is open to several objections. The crown is so small that it would be difficult to make a long guide with the required amount accurately apportioned to each foot of

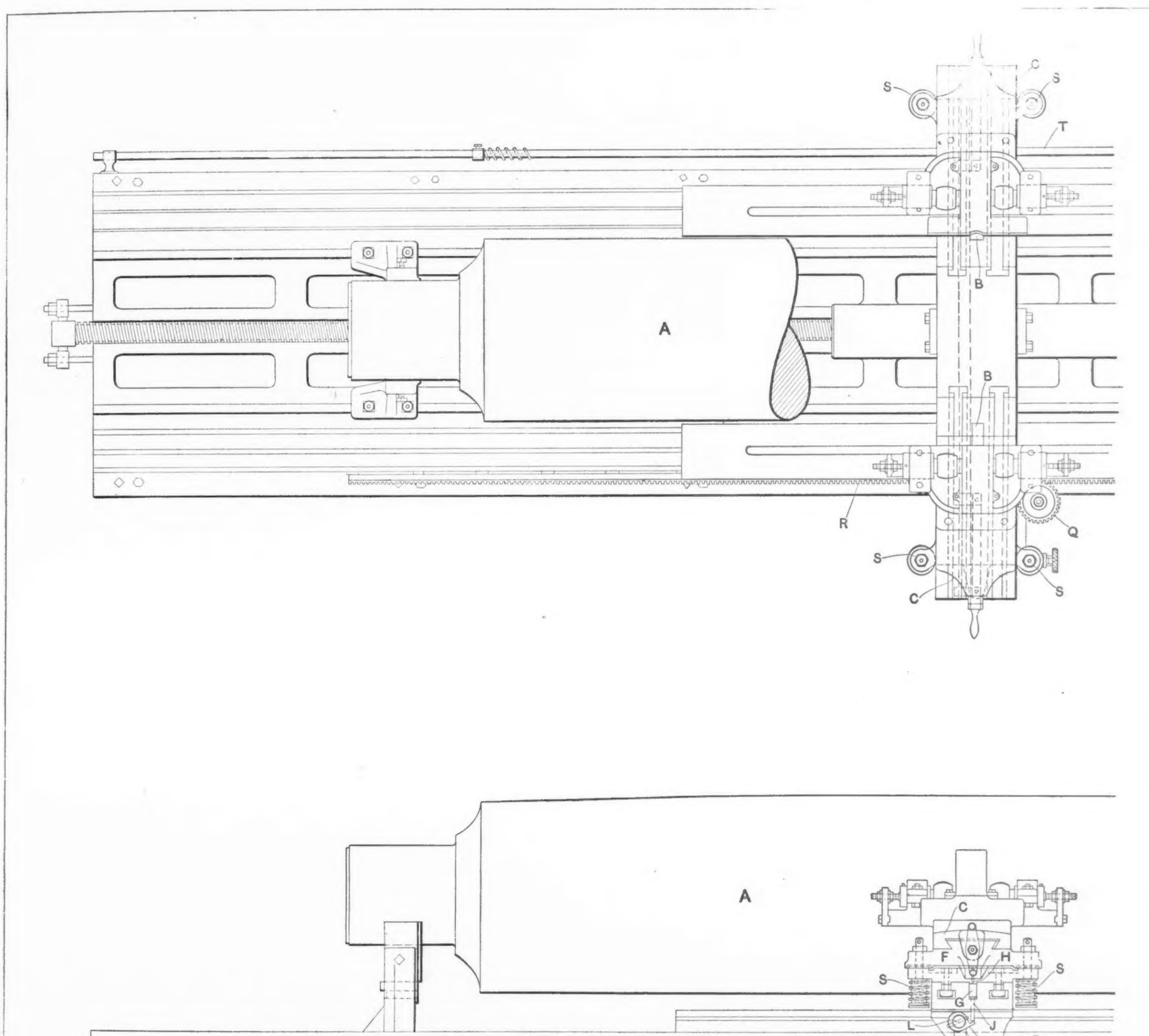


Fig. 4. Plan and Elevation of Lobdell Roll Grinding Machine showing Construction of Carriage and Crowning Device

its length. (See Fig. 3.) The crown being so small, the wear of the guide shoes and deflections would tend to destroy its accuracy. Another objection is that either a large number of formers or guides must be provided or means for changing the shape of the guide by set-screws. The latter are objectionable because of the practical impossibility of making the crown uniform. When these difficulties are understood, the fine points of the Lobdell crowning device will be better appreciated.

The construction of the roll crowning device is shown in Figs. 4 and 5. The roll *A* is mounted by the ends in V-blocks and is ground by the opposite wheels *B*. The wheels are given a slight in-and-out movement which makes the roll of the shape indicated in Fig. 3, the movement being controlled by the mechanism about to be described.

The rack *R* is bolted to the front of the bed, and engages with a pinion *Q*. This pinion carries a worm which drives the worm-wheel *N*. On the worm-wheel is a crankpin whose throw is adjustable by means of a screw *O*. The crankpin is connected to the lever *K* by connecting-rod *M*. The lever *K* is mounted on a transverse shaft *L* extending across the bed under the carriage bridge. At each end are two short horizontal levers mounted on *L* on which rest vertical pins *J*, which, in turn, support a bar *G*.

roll, 116 inches long. The adjustment required for the crankpin is 0.339 inch eccentricity, that is, it is set to swing in a circle of 0.678 inch diameter. The crown produced is a true arc of a circle in the direction of its length, this fact being indicated by the small diagram within the outline of the roll, Fig. 3.

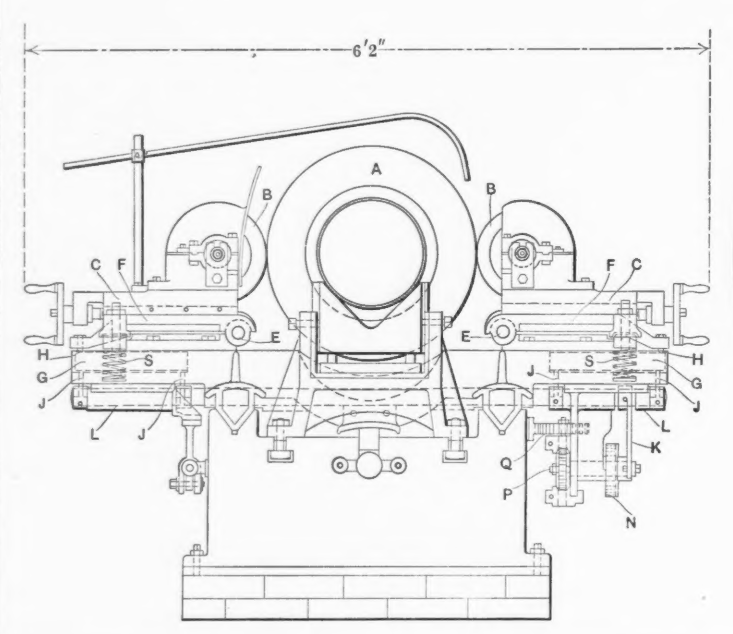
The carriage is traversed by a square feed-screw which bears throughout its entire length in a groove in the bed. The groove is planed accurately to shape in order to form a solid support throughout the length. A half-nut of phosphor-bronze is engaged with the screw. The screw is reversed at the end of the travel by a feed-rod *T* having adjustable collars which shift the reversing gears into engagement.

F. E. R.

* * *

BLUEPRINT MARKING FLUID

A very useful and absolutely permanent marking fluid for writing in white on blueprints, may be made by taking a little soda ash and making a saturated water solution. This may be done as follows: Take a small bottle and nearly fill it with water; then add the soda ash, shaking the bottle from time to time, until the water will not dissolve any more of the crystals. Next strain the solution to remove



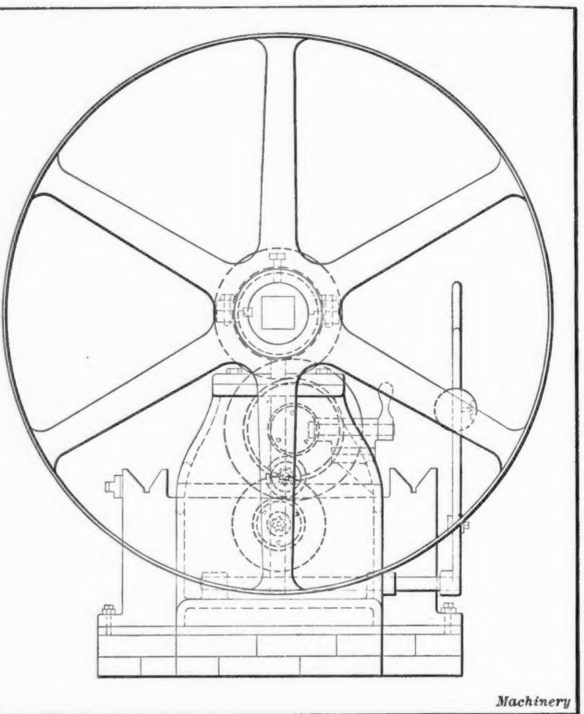


Fig. 5. End View of Lobdell Roll Grinding Machine showing Carriage Construction

Fig. 6. End View of Lobdell Roll Grinding Machine showing Driving Gear for Roll and Carriage

The function of this train of mechanism is to raise and lower the grinding wheel heads on the pivots *E* and to provide means for making the angular movement the same for a given adjustment for any diameter of roll within the capacity of the machine. The point of contact between the bars *G* and the grinding wheel cross-slide heads is at *H*. It is evident that the rise and fall will be the same for a given adjustment no matter at what point *H* contacts with *G*. The wheel slides have two lateral adjustments, one being by means of the screw and handle which moves the top slide on which the wheel is mounted and a lower slide, the base of which is bolted to the carriage but provided with tee-slots for changing the position laterally. The springs *S* are provided to take up the slack in the mechanism and insure the movement of the wheels in the crowning operation following exactly the curve determined by the design of the mechanism.

The operator is provided with a table of roll lengths, diameters, crowns and crankpin adjustments, from which he can read the adjustment necessary for screw *O* to control the position of the crankpin on worm-wheel *N*. The amount of calender or crown has been carefully determined for all lengths and diameters of calender rolls within commercial limits. For example, 0.010 inch crown is given to a 16-inch

the undissolved crystals and any dirt which may be present, and then pour it back into the bottle ready for use. This may be kept indefinitely.

This solution may be applied to the blueprint with either a drawing pen or ordinary writing pen. It works equally well in either case. Where the liquid is applied it bleaches the blue color of the print and leaves it a clear white. It sometimes happens that if the solution has been made too strong, a white powder forms on the lines when they are dry, but this may be brushed off. In such cases, if a little water is added to the bleaching solution there will not be any difficulty of this kind the next time it is used.

If soda ash is not available, an efficient substitute can be prepared by using common baking soda. In this case, however, the lines are not quite so clear and sharp as those produced with the solution of soda ash. If it is desired to make colored lines, a preparation for this purpose may be made by adding ink to a solution prepared according to the preceding instructions. When this is done, the solution bleaches the blueprints so that the colored ink shows up well.

A. C. N.

* * *

Remember that to pull a man down you must get below him.

SCREW MACHINE TOOL EQUIPMENT—2

STANDARD TYPE OF TOOLS USED ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON*

IN the following various types of counterbore, boring tool and reamer holders, together with box-tools for straight and taper turning, will be described.

Standard Adjustable Counterbore, Boring and Recessing Tool-holders

A counterbore holder of the adjustable type is shown at *A* in Fig. 8. The front holder or plate *a* is bolted firmly to the shank *b*, and is adjusted by means of four set-screws *c*, only two of which are shown. This holder is made adjustable in order to set the cutting tool perfectly concentric with the hole in the work.

A somewhat similar type of holder is shown at *B*, but in this case it is used for retaining a boring tool. The front part of this tool is adjustable only by means of two set-screws *d*, which work through the shank of the clamping bolt *e*, and in this way secure the desired adjustment to set the boring tool concentric or to the correct diameter. *C* shows a standard type of recessing tool for use in enlarging a hole back from the end. It comprises a shank *f*, to which is fulcrumed a holder *g* on a stud *h*. This tool is operated by means of a cam *i* held in an arm *j* that is clamped to the cross-slide of the machine. Cam *i* comes in contact with the pin *k* on the holder and operates it after the tool has advanced into the hole in the work. A stud in the sliding part

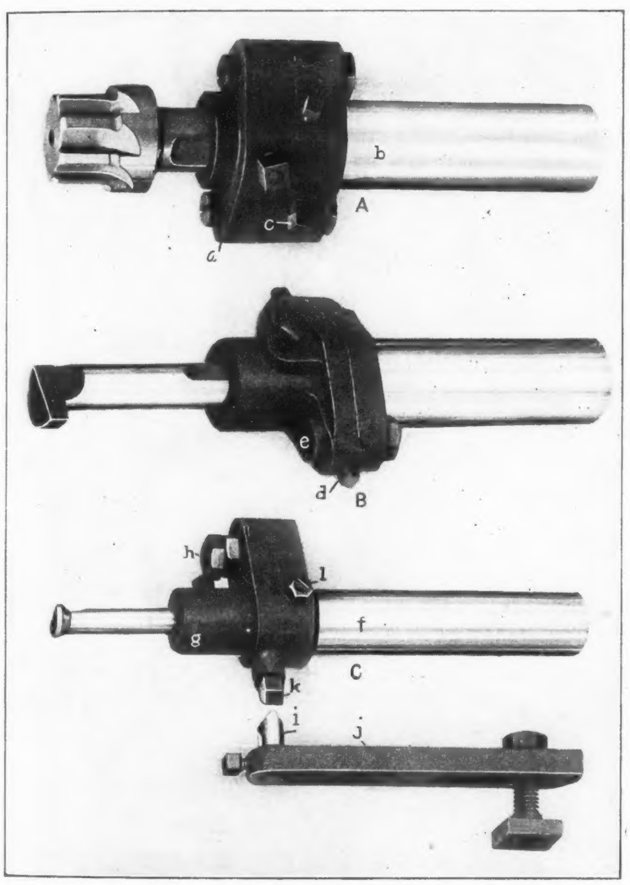


Fig. 8. Standard Adjustable Counterbore Boring and Recessing Tool-holders

of this holder is spring-controlled and contacts with the screw *k* which acts as a stop for setting the cutting tool in a concentric position to enter the hole in the work.

High-speed Drill, Boring and Reaming Tool-holders

A high-speed drill-holder that can be used on the larger sizes of machines for increasing the speed of small drills in the turret is shown in Fig. 9. The revolving spindle *a* is mounted in two bronze bearings with the driving gear *b* shown at *B*. The thrust is taken on the ball bearing *c* shown at *C*. The drill chuck *d* is of the spring collet type. The shank *e* is ground to fit the tool hole in the turret and the rear end of this shank is a reservoir for oil which lubricates all the bearings in the holder. Sufficient oil should be put in at the point *f* to completely fill the reservoir. For holding small reamers the spindle *a* is especially constructed to receive a floating type of reamer-holder instead of the drill-

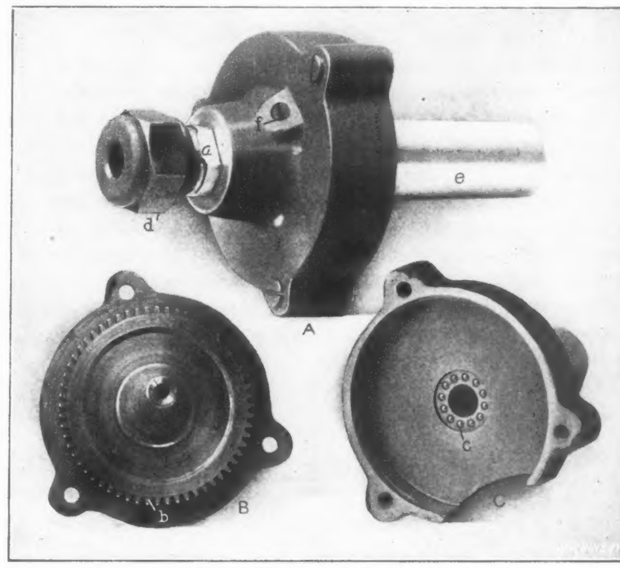


Fig. 9. High-speed Drill-holder

holder shown. This holder is driven by a shaft running through the turret shaft and a small pulley belted to the overhead works.

The holder just described is also made up to use with a boring tool and it is shown fitted up in this manner in Fig. 10. In this case the front end of the holder comprises a chuck *a* which is dovetailed to the front part of the holder and is held in position by two studs on which nuts, as illustrated, are fastened. The boring tool is held in this holder by means of a hollow hexagon set-screw. This tool enables boring to be accomplished at a high rate of speed and also gives sufficient adjustment so that the boring tool can be set to bore accurately to size. It is especially adapted for driving small boring tools at a high rate of speed when all the other tools in the turret are larger and require a slow spindle speed for the work.

Roller Steadyrest, Shaving and Roughing Box-tools

A simple steadyrest of the roller support type is shown at *A* in Fig. 11. The roller supports *a* are held in slides *b* which are adjusted by means of screws *c*. The slides are then clamped in the desired position by means of the clamp bolts *d*. A simple type of shaving box-tool is shown at *B* in Fig. 11. This tool is provided with V-supports as illustrated, which are adjusted by the collar-head screw *e* and are clamped in position by means of the clamp bolts *f*. The turning tool *g* is adjusted by a collar-head screw *h* and is held in position by a set-screw *i*. This tool is of very simple construction and is used where only one diameter is to be turned at a time.

C in Fig. 11 shows the standard roughing box-tool. This tool is provided with roller supports which are held and operated in a similar manner to that shown at *A* in Fig. 11, and the turning tool *j* is held in a square hole provided in the stud *k*; this stud clamps the turning tool against the face of the box-tool holder. Adjustment for height is secured by means of the set-screw *l*. Two set-screws, one shown at *m*, act as an adjustment for stud *k*.

The type of box-tool shown at *A* in Fig. 12 accommodates three turning tools, and can also carry a centering tool or drill, which is held in the shank of the holder. The flat arm or member *a* of this box-tool has two splines cut in its face

* Associate Editor of MACHINERY.

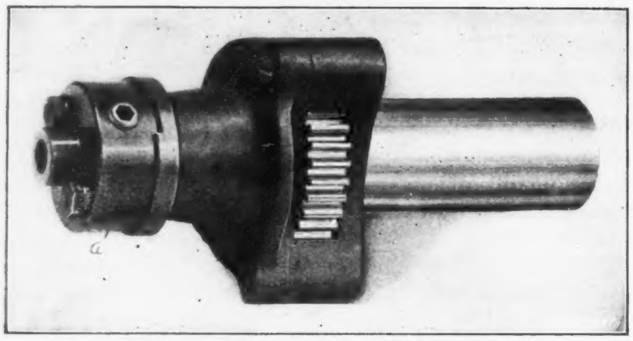


Fig. 10. High-speed Adjustable Boring Tool

the full length, in one of which the three holders *b* for the cutting tools are held, and in the other two the brackets *c* for roller supports. The roller supports are held in the same manner as previously described. This box-tool can be used for turning three different diameters at one setting and is used for roughing or finishing purposes. The roller supports may be adjusted to lead or follow the cutting tools by simply moving them along the slot in the holder. The brackets carrying the supports can be placed in any desired position and the holders for the cutting tools can also be adjusted to suit the various diameters and lengths of shoulders on the work.

An adjustable type of roughing hollow mill is shown at *B* in Fig. 12. This is supplied with four cutters *d* which are

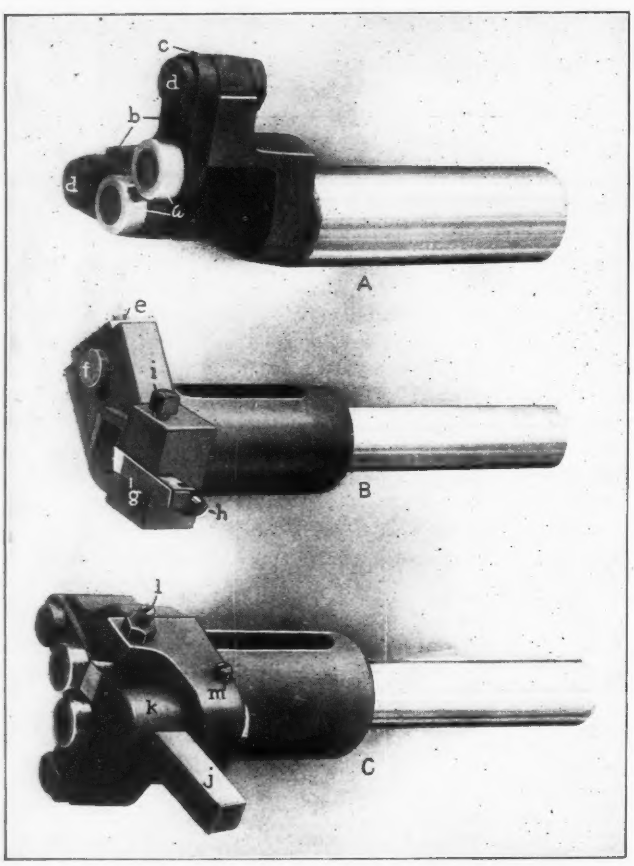


Fig. 11. Roller Steadyrest, Shaving and Roughing Box-tools

adjusted as shown. The flat arm *e* of the box-tool has a spline cut the full length, and also a slot through which the studs enter. The studs are made integral with the cutter-heads and are clamped by nuts as shown. The four cutters in the head are adjusted by removing the head from the arm and placing it on a stand fitted with a plug gage of the same diameter as the work to be turned. This stand holds the cutter-head in the correct relation to the plug gage so that the tools can be brought into contact with the plug gage and then clamped. This tool is also supplied with a hole in the shank for holding a centering tool or drill. The heads for the cutters are adjustable along the body of the holder.

Another type of box-tool is shown at *C* in Fig. 12. This is of open-type construction and is supplied with one turning tool clamped to its face as illustrated, the work being supported at this point by roller supports. The second tool, which is set at an angle and held down by a heel clamp, can be used for turning a second diameter on the work; the work is supported with V-supports held in the projection of the holder as illustrated. This tool-holder is of simple construction and embodies the general principles incorporated in the other holders previously described.

Taper Turning Box-tools

The taper turning box-tool shown in Fig. 13 is held by a shank in the turret of the machine and is supplied with a bushing on the front end which guides the work. The

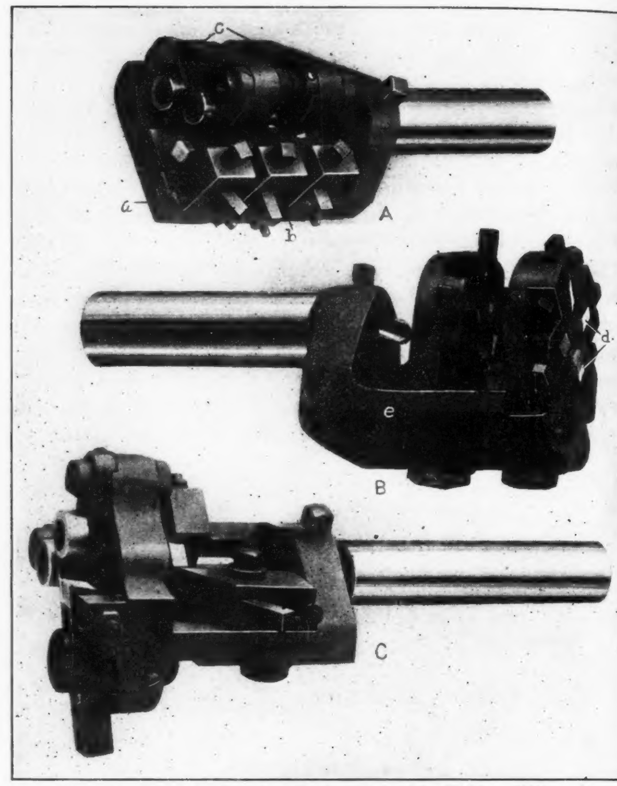


Fig. 12. Multiple Turning Tool, Adjustable Hollow Mill and Standard Three-tool Box-mill

circular slide *A* carries the turning tool *B* and is fitted with a pin *C* which comes in contact with the adjustable guide *D* held on the cross-slide. When the turning operation is completed, the cross-slide recedes, allowing a spring located inside the holder to move the slide *A* back to its original position. The guide *D* held on the holder *E* which is attached to the cross-slide can be made of any shape so that any irregular form as well as tapered work can be secured. This guide is fulcrumed on a pin in the bracket and is supported and adjusted by two set-screws as illustrated.

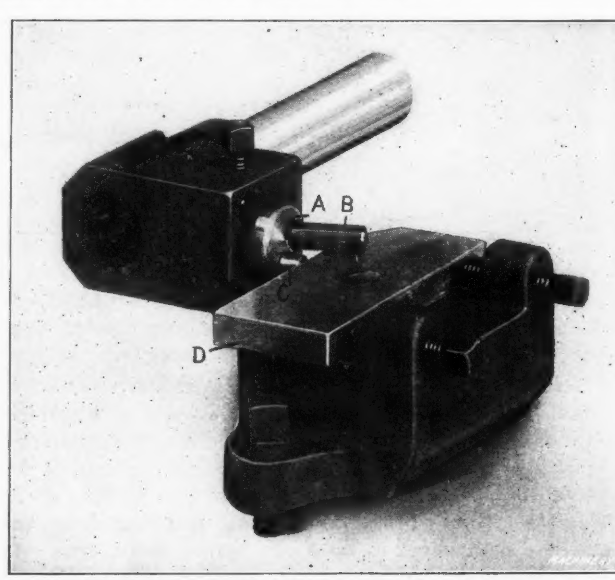


Fig. 13. Turning Tool for Taper or Irregular Shapes

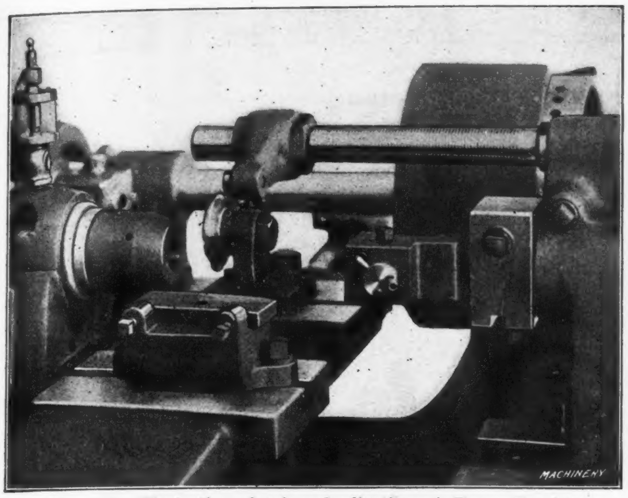


Fig. 14. Illustration showing Application of Taper Turning Tool presented in Fig. 13

Fig. 14 shows how this taper turning box-tool is operated. Here it can be seen that the guide is fastened to the cross-slide of the machine. The taper turning tool in this case, however, is held in the spindle of the plain type of machine, not the turret type.

The peripheral speeds in feet per minute recommended for box-tools and external cutting tools, in general, when provided with high-speed cutters, are as follows:

Brass	180—250
Cold-rolled Steel	120—150
Tool Steel	50— 60

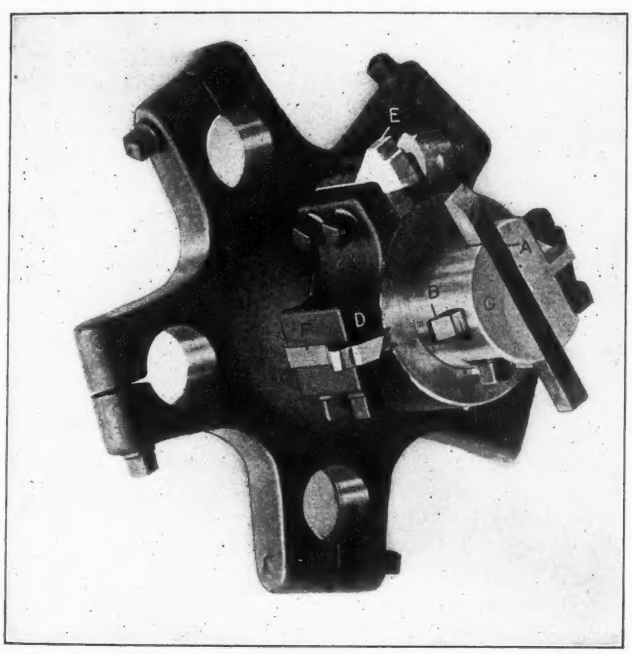


Fig. 15. Overhanging Turning Attachment with Extra Cutter-head

Overhanging Turning Attachment

The turning attachment shown in Fig. 15 is attached to the face of the turret by a clamp which surrounds the shanks of the turret tools. This attachment is put in position before any of the other tools in the turret so that the shanks of the other tools can pass through the holes in the five arms of the holder. The various arms, which are split, are then clamped by the set-screws shown. This type of tool can be used for performing a multiplicity of operations. In this particular case it is set up with roughing and finishing tools. The roughing tool *A* and the finishing tool *B* are mounted in the stem *C*. Also an extra cutter-head *D* is supplied with cutters *E* and *F* for rough- and finish-counterboring. The cutter-head can be adjusted longitudinally so that any desired relation can be obtained between the cutter *A* and the cutters in the cutter-head *D*. Attachments of this type are particularly adapted for over-turning in connection with flat forming tools, and for this work it is sometimes necessary to have the shank much longer than is shown in the illustration. This part is therefore made according to the requirements.

Die- and Tap-holders

The types of die- and tap-holders used in the Cleveland automatics do not differ from those on any other type of automatic screw machine; two representative types are shown in Fig. 17. That at *A* is a releasing button die-holder, while that shown at *B* is a releasing tap- or die-holder. The tap-holder, of course, is provided with bushings for holding taps having shanks of different diameters. As a rule, automatic opening dies are used on Cleveland automatics, but spring or button dies of the type shown at *C* and *D* can be used to good advantage, especially on brass work.

Adjustable Knurling Tool-holders

At *C* in Fig. 2 is shown a knurling tool-holder that can be used on the cross-slide for knurling thumb-screws or for straight knurling. It cannot, however, be used for longitudinal knurling. This knurling tool-holder consists simply of a base carrying an arm fulcrumed on a pin. Adjustment for height is secured by the set-screw *e* and the knurl is held on a stud by a nut, the stud passing through the arm as illustrated.

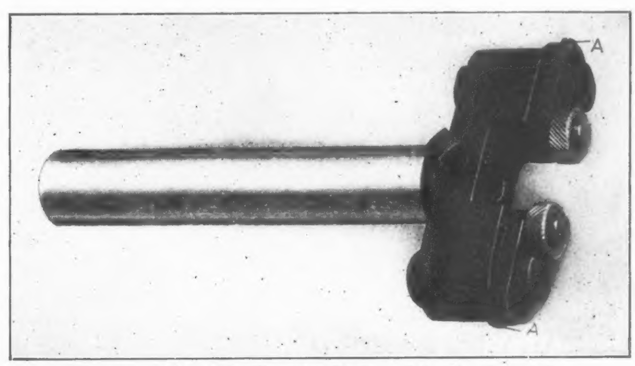


Fig. 16. Adjustable Knurling Tool used in the Turret for Spiral or Diamond Knurling

A knurling tool-holder which can be used for diamond or straight knurling is shown in Fig. 16. This holder is carried in the turret and is provided with two adjustable knurling holders that are held in a groove in the face of the shank by a stud and nut as shown. Adjustment is secured by means of the headless screws *A*. The knurls are held on plain studs which are driven into the adjusting members and held from turning by the small set-screws shown. This type of holder is used exclusively for knurling longitudinally.

* * *

It may be a surprise to many to know that there are in the United States not less than 37,000 electric vehicles in use. Of these nearly 3000 are registered in Chicago, 2000 in New York, and 1800 in Cleveland.

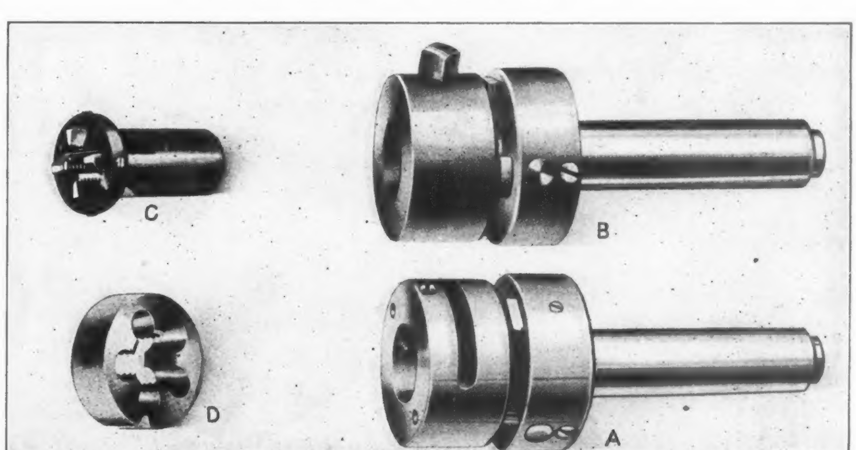


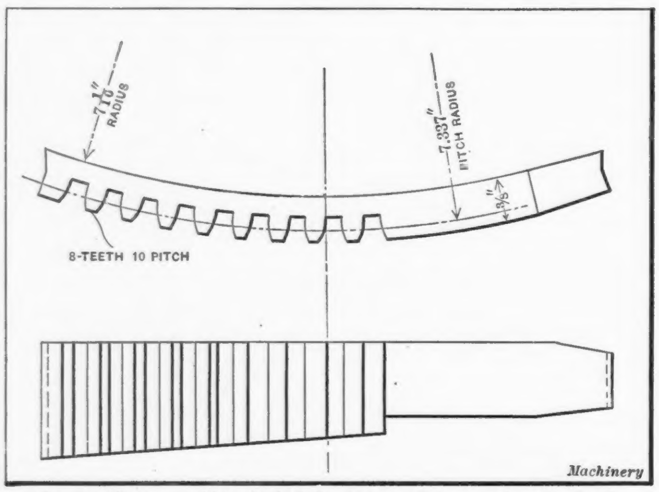
Fig. 17. Releasing Tap- and Die-holders

INDEXING MOVEMENTS FOR SMALL ANGLES ON MILLING MACHINE

BY P. J. RYAN*

Ordinarily, it is assumed that the only method for exactly indexing small angles is by moving the indexing pin one hole in the 27-hole circle, which gives an indexing movement of 20 minutes, or one hole in the 18-hole circle, which gives an indexing movement of 30 minutes. However, the writer has used a very simple method for a number of years which makes it possible to index angles accurately to 1 minute. This consists of using the rear pin which is a part of every dividing head, and which is used for holding the index plate in a fixed position while indexing in the usual way. This pin may also be used to index in an opposite direction to that of the regular indexing-arm pin, in a different circle, or to index in the same direction, thus adding to or subtracting from the movement made by the indexing-arm pin.

The method is very simple. For instance, if we use the plate with the 20-hole circle on the outside, the back pin will be in the 20-hole circle and the regular indexing pin may be placed in the 18-hole circle; by simply withdrawing the rear pin from the 20-hole circle and turning the plate backward or counter-clockwise one hole, and again inserting the pin, and then withdrawing the regular indexing pin from the 18-hole circle and moving it one hole in the 18-hole circle clockwise, we will have moved the work through an arc of exactly three minutes, and can, therefore, index any angle within a maximum error of 1½ minute. In this way, any part of an angle greater than 30 minutes may be indexed by first moving one hole in the 18-hole circle for each 30 minutes and then indexing the remainder within 1½ minute by moving one hole backward in the 20-hole circle and one hole forward in the 18-hole circle for every three minutes.



Circular Rack on which Method No. 3 is used for spacing the Teeth

A still more accurate result may be obtained by placing the plate having the 27-hole circle on the outside of the 20-hole plate and pinning the two together through any two holes which happen to come opposite each other. This is equivalent to having a plate with both a 20- and a 27-hole circle. With this arrangement an exact movement of 1 minute may be had by moving the pins three holes in the 20-hole circle in a clockwise direction and then the regular index-arm pin four holes in the 27-hole circle in a counter-clockwise direction. This gives a movement to the dividing head of 1 minute in a clockwise direction, so that all angles may be thus indexed with an error which cannot exceed 30 seconds.

Table I shows the two methods outlined above for angles less than 30 or 20 minutes, respectively. It is not necessary

* Address: 196 Walker St., Lowell, Mass.

TABLE I. INDEXING MOVEMENTS FOR SMALL ANGLES

Method No. 1 — Using 20-hole index plate only			Method No. 2 — Using 20-hole index plate inside and 27-hole index plate outside, pinned together through any two opposite holes					
Angle in Minutes	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Clockwise	Angle in Minutes	First Indexing Movement; Back Pin; Clockwise	Second Movement; Index Arm Pin in 27-hole Circle; Counterclockwise	Angle in Minutes	First Indexing Movement; Back Pin; Clockwise	Second Movement; Index Arm Pin in 27-hole Circle; Counterclockwise
3	1/20	1/18	1	3/20	4/27	11	13/20	17/27
6	2/20	2/18	2	6/20	8/27	12	16/20	21/27
9	3/20	3/18	3	9/20	12/27	13	19/20	25/27
12	4/20	4/18	4	12/20	16/27	14	2/20	2/27
15	5/20	5/18	5	15/20	20/27	15	5/20	6/27
18	6/20	6/18	6	18/20	24/27	16	8/20	10/27
21	7/20	7/18	7	1/20	1/27	17	11/20	14/27
24	8/20	8/18	8	4/20	5/27	18	14/20	18/27
27	9/20	9/18	9	7/20	9/27	19	17/20	22/27
30	..	1/18	10	10/20	13/27	20	..	1/27*

Machinery

*Clockwise movement in this case

TABLE II. INDEXING MOVEMENTS FOR SMALL ANGLES

Method No. 3. Using 20-hole index plate inside and 27-hole index plate outside, pinned together through any hole in the outside plate and the 16-hole circle in the inside plate

Angle Min.	Angle Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise	Angle Min.	Angle Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise	Angle Min.	Angle Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise	Angle Min.	Angle Sec.	First Indexing Movement; Back Pin; Counterclockwise	Second Indexing Movement; Index Arm; Counterclockwise	Third Indexing Movement; Locking Pin; Clockwise
	15	3/20	1/27	3/16	5	15	3/20	21/27	15/16	10	15	3/20	14/27	11/16	15	15	3/20	7/27	7/16
	30	6/20	2/27	6/16	5	30	6/20	22/27	1 2/16	10	30	6/20	15/27	14/16	15	30	6/20	8/27	10/16
	45	9/20	3/27	9/16	5	45	9/20	23/27	1 5/16	10	45	9/20	16/27	1 1/16	15	45	9/20	9/27	13/16
1		3/20*	4/27	..	6		18/20*	24/27	...	11		13/20*	17/27	...	16		8/20*	10/27	...
1	15	15/20	5/27	15/16	6	15	15/20	25/27	1 11/16	11	15	15/20	18/27	1 7/16	16	15	15/20	11/27	1 3/16
1	30	18/20	6/27	1 2/16	6	30	18/20	26/27	1 14/16	11	30	18/20	19/27	1 10/16	16	30	18/20	12/27	1 6/16
1	45	1/20	7/27	5/16	6	45	1/20	..	1/16	11	45	1/20	20/27	13/16	16	45	1/20	13/27	9/16
2		6/20*	8/27	..	7		1/20*	1/27	..	12		16/20*	21/27	...	17		11/20*	14/27	...
2	15	7/20	9/27	11/16	7	15	7/20	2/27	7/16	12	15	7/20	22/27	1 3/16	17	15	7/20	15/27	15/16
2	30	10/20	10/27	14/16	7	30	10/20	3/27	10/16	12	30	10/20	23/27	1 6/16	17	30	10/20	16/27	1 2/16
2	45	13/20	11/27	1 1/16	7	45	13/20	4/27	13/16	12	45	13/20	24/27	1 9/16	17	45	13/20	17/27	1 5/16
3		9/20*	12/27	..	8		4/20*	5/27	..	13		19/20*	25/27	...	18		14/20*	18/27	...
3	15	19/20	13/27	1 7/16	8	15	1[illegible]/20	6/27	1 3/16	13	15	19/20	26/27	1 15/16	18	15	19/20	19/27	1 11/16
3	30	2/20	14/27	10/16	8	30	2/20	7/27	6/16	13	30	2/20	..	2/16	18	30	2/20	20/27	14/16
3	45	5/20	15/27	13/16	8	45	5/20	8/27	9/16	13	45	5/20	1/27	5/16	18	45	5/20	21/27	1 1/16
4		12/20*	16/27	..	9		7/20*	9/27	..	14		2/20*	2/27	...	19		17/20*	22/27	...
4	15	11/20	17/27	1 3/16	9	15	11/20	10/27	15/16	14	15	11/20	3/27	11/16	19	15	11/20	23/27	1 7/16
4	30	14/20	18/27	1 6/16	9	30	14/20	11/27	1 2/16	14	30	14/20	4/27	14/16	19	30	14/20	24/27	1 10/16
4	45	17/20	19/27	1 9/16	9	45	17/20	12/27	1 5/16	14	45	17/20	5/27	1 1/16	19	45	17/20	25/27	1 13/16
5		15/20*	20/27	..	10		10/20*	13/27	...	15		5/20*	6/27	...	20		1/27*	..	...

Machinery

*Clockwise movements in these cases

to show figures for any greater angle than 30 minutes by method No. 1 or 20 minutes by method No. 2, as any angle greater than these may be indexed directly either in the 18-hole or 27-hole circles by well-known methods. (These methods are explained in MACHINERY'S Reference Book No. 18, "Shop Arithmetic for the Machinist," and in MACHINERY'S HANDBOOK, pages 935 to 937, inclusive.)

When it is possible to use the No. 1 method, it should be employed because of its simplicity, provided a degree of accuracy within 1½ minute is sufficient. For all ordinary work, this is the case. If a greater degree of accuracy is desired, the No. 2 method should be employed. As an example of the No. 2 method, assume that it is required to index for an angle of 39 degrees 56 minutes. First index by the usual methods, as referred to above, 39 degrees and 40 minutes by direct indexing in the 27-hole circle; the movement in this case would be four complete turns, and then 11 holes in the 27-hole circle. Next index for 16 minutes by moving the back pin 8 holes in the 20-hole circle in a clockwise direction, and then moving the indexing-arm pin 10 holes in the 27-hole circle in a counter-clockwise direction. This will give a total movement of the work of 39 degrees 56 minutes.

Table II gives the movements necessary for method No. 3, which enables smaller angles to be indexed than are obtained by either of the preceding methods. While this table is arranged for indexing angles, it can also be used to obtain any number of divisions or fractions of a division by simply dividing the number of seconds in a circle, *i. e.*, 1,296,000, by the required number of divisions, the quotient being the required angle to index for expressed in seconds. The maximum error of the result obtained in this way never exceeds 7½ seconds.

This method consists of using two index plates as in the case of method No. 2, but an additional movement is obtained by moving the outside plate in its relation with the inside plate, by means of the small plug in the 16-hole circle, which is employed in method No. 2 to lock the plates together. The illustration shows a piece of work which we recently handled by this method. It was necessary to cut 10-pitch teeth on a circular rack or segment which was to operate in a slot 14.875 inches outside diameter. On this diameter we would have had to index for 146.75 teeth if the teeth had been accurately cut. Converting this result to an angular movement, it is found that it would be necessary to index through an angle of $1,296,000 \div 146.75 = 8835.8$ seconds $= 2$ degrees, 27 minutes, 15.8 seconds for each tooth.

The larger part of this angle, *i. e.*, 2 degrees 20 minutes, was first indexed directly in the 27-hole circle, by moving through seven holes in a clockwise direction. This leaves an angle of 7 minutes 15.8 seconds to be indexed. The necessary movement can be obtained from Table II and a result secured which is within 0.8 second of accurate. The necessary movement for this angle of 7 minutes 15 seconds is first, 7 holes counter-clockwise in the 20-hole circle; second, 2 holes counter-clockwise in the 27-hole circle; third, 7 holes clockwise in the 16-hole circle. Canceling the opposite movements in the 27-hole circle we find that the resulting movement necessary to obtain an angle of 2 degrees 27 minutes and 15 seconds is first, 7 holes counter-clockwise in the 20-hole circle; second, 5 holes clockwise in the 27-hole circle; third, 7 holes clockwise in the 16-hole circle. The error should never exceed 7½ seconds, as when this error occurs it is only necessary to index for 15 seconds and wait for the error to accumulate again. This method may appear complicated, but in reality it is quite simple when it has once been thoroughly mastered.

* * *

ANNEALING STEEL CASTINGS

The following method of annealing steel castings was adopted by the American Society for Testing Materials, and referred to the members for letter ballot at the Atlantic City meeting.

1. The castings should preferably be sufficiently cleaned of adhering sand before annealing to insure thorough and uniform heating.

2. The castings should be heated slowly and uniformly to temperatures (in degrees C.) varying with the carbon content of the steel, and approximately as follows:

Up to 0.16	925
0.16 to 0.34	875
0.35 to 0.54	850
0.55 to 0.79	830

Nothing in these recommendations shall operate against the temperatures aimed at being 50 and, in special cases, 100 degrees C. higher than those given in the table, when necessary to attain the desired result.

3. The castings should be kept at the maximum temperature a sufficient length of time to insure the refining of the grain. In general, the heavier the sections of the casting, the longer must be the time of exposure to the maximum temperature.

4. (*a*) The castings should be cooled slowly and uniformly in the furnace, when it is desired that the steel shall possess the maximum softness.

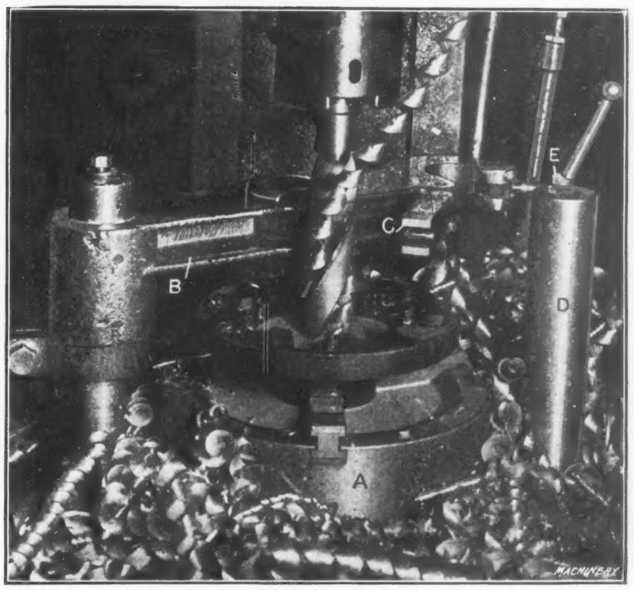
(*b*) The castings may be cooled at an accelerated rate, when it is desired that the steel possess rather higher tensile strength and elastic limit than can be procured by very slow cooling. This cooling must be so conducted as to leave the steel reasonably free from cooling stresses.

The manner of carrying out this accelerated cooling should be such as will attain the desired result. For instance, the castings may be withdrawn from the furnace and buried in a bed of material that is a poor conductor of heat; or the annealing furnace may be so thrown open that it will cool more rapidly than if left closed. Should the castings be of such uneven section that they cool at unequal rates at various points when the furnace is opened, especially if the carbon of the steel is high, the furnace should be closed after the castings have become black, and their further cooling so retarded that the stresses set up by the unequal rates of cooling are relieved.

* * *

A SPOTTING JIG

In the drilling department of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., a spotting or centering jig for drilling heavy work is employed. This is shown in the illustration and its purpose is to locate the drill while it is spotting the work, after which it may be swung aside to allow the chips to emerge freely. In the illustration the work has been spotted and the arm swung clear to permit the chips to leave the drill freely. On the job in question the work is circular, and is held in the universal chuck *A*. After locating the work, the arm of the jig *B* that has a bushing at the center is swung into position and latch *C* is thrown around the post *D* and held there by lock *E*. After the hole has been spotted, the lock is loosened, the latch opened and arm *B* is swung out of the way, thus allowing plenty of chip room. C. L. L.



Spotting Jig with Arm clear of the Work

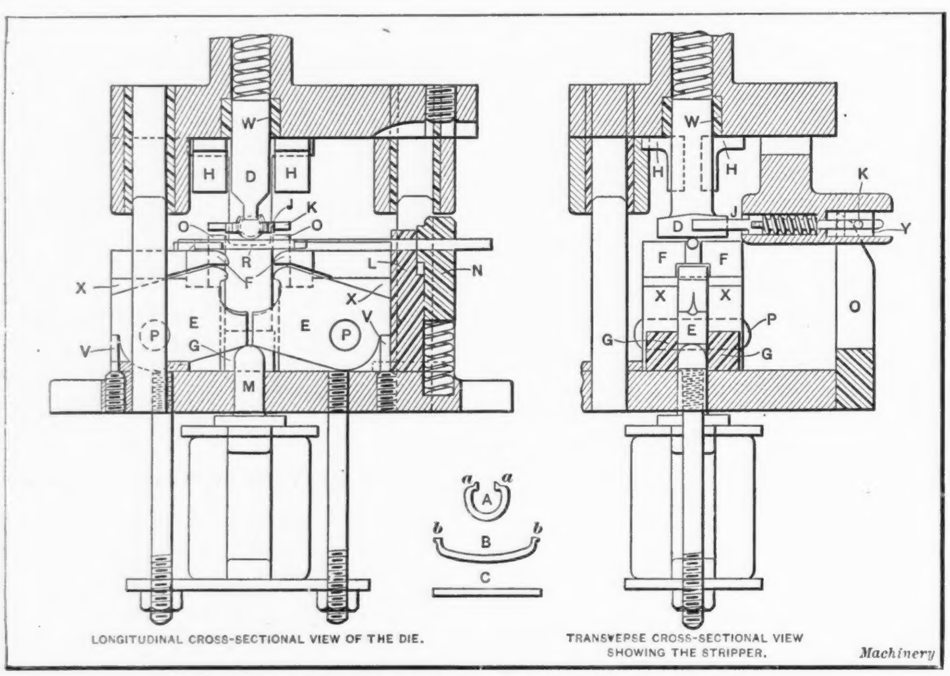
A CUTTING AND BENDING DIE

BY SPRING CRAIG*

The part shown at *A* in the accompanying illustration is used to support an electric light fixture. These parts are sold in lots of from 10,000 to 100,000; they are made of 7/32-inch polished brass rod, and a particularly interesting punch and die is employed for cutting off the blanks and bending them to the required shape.

It frequently happens that difficult problems in die work find their way to jobbing shops which are the headquarters of traveling tool- and die-makers. These men seldom stay in one place for any great length of time; they keep moving from place to place, and I have known those who have worked in upward of one hundred different shops. Likewise, some of the traveling mechanics whom I have met have been across the continent and back; and in at least one case I came across a man who had worked his way around the world and was familiar with more languages than English and profanity.

At that time I was somewhat of a nomad myself and the job of making the punch and die for producing these parts was turned over to me after several men had failed to produce a satisfactory tool. The only requirement was that the work should be produced in not more than three operations. The idea was to cut off blanks of the form shown at *C*, and then bend them to shape in two operations, as shown at *B* and *A*. Difficulty was experienced in bending the ends *a* and after some experimenting we came to the conclusion that in performing the second operation the ends *b* would have to be bent in to more than a right angle. To accomplish this, a very expensive punch and die would have been necessary, even if the desired result could have been obtained under any circumstances.



Combination Cutting and Bending Die for making the Piece shown at A

After working on the problem for eight or nine days, I decided to discard this method. The proprietor of the shop had put the job up to me and given me a free hand to work my own way. The result was that I finally managed to develop the punch and die which form the subject of the present article. This tool finishes the work complete in one operation and has a capacity for producing 10,000 pieces a day.

The design will be readily understood from the accompanying illustration which shows longitudinal and transverse cross-sectional views through the punch and die. The bed is made of cast iron and has four upright members *X* cast integral with it. The two upright pieces at the right-hand end of the die have slots milled in them at an angle of 60 degrees, these slots being employed to control the movement of the cut-off slide *N*. The two parts *E* are fitted between the uprights *X* and are machined to the form of the work which it is required to produce. These members *E* are carried by two hardened and ground pivots *P* about which they swing to bend the work around the punch. The two screws *V* are adjusted to hold the dies *E*, so that they cannot swing open too far. The plunger *M* is actuated by a rubber bumper which holds the dies *E* open except when the punch comes down; this bumper also opens the dies after the punch has completed its working stroke.

The cut-off mechanism consists of two members *L* and *N* which are made of tool steel and have a hole drilled through them a little larger than the stock which is to be cut off. The member *L* is held stationary while the slide *N* is free to move up and down, its movement being controlled by the 60-degree slots in the pieces *X*, which were referred to in a previous paragraph. When the ram of the press descends, a screw in the punch-holder is adjusted so that it pushes the slide *N* through a sufficient distance to cut off the blank. After the shearing operation has been completed, the spring under the slide *N* returns it to the starting point, where the holes in the members *N* and *L* are in line ready to have the stock for the next piece fed through.

The two pieces *F* are made of tool steel. They are mounted on top of the uprights *X*, above the dies *E*. These pieces have a groove on their upper face of the required size to receive the stock that is to be bent in the die. It will be seen from the illustration that the ends of the pieces *F* are machined in such a way that the work will be bent smoothly over them when the punch *D* comes down. The same ends are cut away on the sides a short distance back to allow the blocks *H* to straddle the pieces *F*. As the ram descends, the punch carries the work down between the dies *E*, and continued movement of the ram causes the blocks *H* to come in contact with the dies *E*. This causes the dies *E* to be forced inward with the result that the ends *a* of the work are bent to the required form around the core on the punch *D*. The punch works in a steel bushing *W* and is backed up by a heavy compression spring. The downward travel of the punch is limited by having its ends come in contact with the blocks *G* which are clearly shown in the transverse sectional view. The press continues its travel for another 1/16 inch, and it is this 1/16 inch of over travel which causes the blocks *H* to engage the dies *E* and set the ends of the work *a* to the required form.

On the up-stroke of the press the stripper *J* is released and pushes the work off the punch. This stripper is made in the form of a fork, its design being clearly shown in the transverse sectional view. It is placed at the back of the die because it would be in the operator's way if it were located at the front. The stripper *J* straddles the punch, and the piece *Y* is threaded at the small end to screw into the boss connecting the two prongs. A hole is drilled in the opposite end of the stripper and a hardened piece of drill rod *K* is driven into it. This piece of drill rod comes in contact with the forked cam *O*. When the punch-holder comes down, the cam *O* engages the pin *K* and pulls the stripper out of the way, causing the spring behind it to be compressed. This spring is released on the up-stroke of the press, thereby moving the stripper forward and knocking the piece of work off the punch. This tool has given most satisfactory results. It requires very little care to maintain it in operating condition and, as previously stated, has a capacity for producing 10,000 pieces per day.

* Address: 301 Church St., Toronto, Canada.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

UNIFICATION OF WEIGHTS AND MEASURES —FOR AND AGAINST

We notice with a great deal of pleasure in the July number of MACHINERY your editorial, "Unification of Weights and Measures," and wish to thank you for the very sensible stand you are taking in the matter, and without, as you say, going into the merits of the controversy "Metric vs. English System."

We here have adopted the metric system and apply it to such things and operations as we can conveniently, though it is still necessary to purchase many materials and to do many things with the English system, but we shall welcome the day that will surely come when the metric system is universal.

It is only too true, as you say, that the longer the change is put off the more difficult it will be, and so we hope the changing will not be put off much longer.

THE DELAVAL SEPARATOR CO.,
Poughkeepsie, N. Y. T. H. Miller, Supt.

To put it mildly, I was surprised to see the editorial favoring the metric system in the July number. You should have known better than to express an opinion favorable to the system, and assuming that your words were intended to mean what they appear to mean, you should have known better than to repeat the stale untruth "It is already used by three-fourths of the civilized world." Have you forgotten the official "confession" of the French minister of Commerce, Industry and Labor, published in the transactions of the American Society of Mechanical Engineers, Vol. XXVIII, page 877? Let me remind you that this official is charged with the enforcement of the law for the suppression of old units of measurements in France, and that in this confession he acknowledges himself powerless to do it, and plaintively appeals to local chambers of commerce to use their influence to persuade where the law is unable to compel. This official confession confirms all that has been said regarding the continued use of old units in France after more than a century of effort to suppress them. Explain if you can in any way creditable to the system this continued preference for old units by the French people.

This state of things exists, although the metric system was introduced in France before the large development of organized industry and when the change was, comparatively speaking, easy. Among the few organized industries in existence there at that time was the manufacture of silk fabrics, and this is precisely the industry which adheres most tenaciously to its old units and which illustrates most forcibly the impossibility of changing units of measurement in organized industry. Another and wider illustration is the lumber industry, for throughout metric Europe lumber is sawn to the inch and to nothing else; and similar illustrations can be repeated indefinitely.

Wherever the adoption of the system has been attempted, the result has been a partial adoption—adoption in fields of use in which the change is easy, and failure to adopt in other fields. Now the entire metric case is based on the tacit assumption that the old units are to disappear, but this they have not done in any metric country on earth. If the old units are to continue, every metric argument is annulled and inverted. Instead of uniformity the result is confusion; instead of ratios between units being simpler and more uniform, they become more complex and diverse; instead of calculations being simplified they become more complex by reason of the repeated conversions required between old and new units. Witness the extended conversion tables of English and metric units with which reference books are burdened and which are made necessary by the use of two systems side by side. You should read Mr. Dale's exposition of the effect of the superposition of metric commercial units on the old factory units of the textile industry of all metric Europe. The result is a state of chaos that defies description, and it is precisely to this state that the "adoption" of the metric system in our mechanical industries would lead. So far as "academic discussion" is concerned it is the metric party that is made up of academicians. It is the metric party that chases rainbows while the anti-metric party studies facts. The metric party presents the system as imagination conceives it to be, while the anti-metric party presents the case as it is.

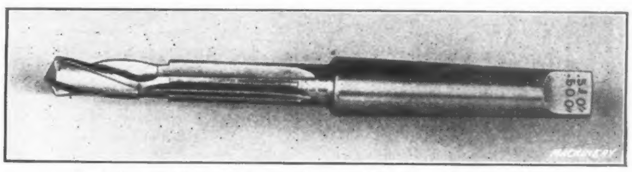
I have, however, no intention of presenting an extended argument here. My forthcoming book, "Methods of Machine Shop Work," contains a discussion of this subject as releated to the machine shop, and I refer you and your readers to it in lieu of a repetition of the same facts here. Let me add, however, that no candid man can study the metric system, not as it is conceived to be, but as it is, and fail to decide against it, for there never was a case in which the theory and the facts are so opposed. F. A. HALSEY

New York City Editor Emeritus, *American Machinist*

COMBINATION DRILL AND REAMER

In modern machine shop practice, one of the most fruitful methods of increasing efficiency consists of the elimination of unnecessary handling of the parts to be machined. If it is possible to combine two tools so that their work is done in a single operation, the handling and time required to set up the work is reduced in direct proportion, and there is also a reduction in the machining time. It was to secure these advantages that the combination drill and reamer shown in the accompanying illustration was designed.

This tool consists primarily of an ordinary reamer with a standard taper shank and tang to fit in the spindle of an



Tool for drilling and reaming a Hole in One Operation

upright drill press. The cutting end of the reamer has been lengthened and formed into a regular two-lipped twist drill, this drill first entering a cored hole in the casting, cutting away the metal and enlarging the hole to such a size that the reamer may easily follow it. In this way the hole is finished to the standard size in a single operation. It has been found in practice that by combining the two operations in this way, they can be done almost as quickly as either of the individual operations was formerly performed, with the result that a great saving of time has been effected.

A. C. NELLA

COLLEGE OF THE MIDNIGHT LAMP

In these summer months, when schools and colleges are sending out their thousands of graduates, one's thoughts turn naturally to the army of men who do not celebrate commencement nor join the friendly reunions and revels of "class day"—men who perhaps left school at an early age to take their places in the workaday world. Yet many of these men must be classed among the educated, because they have trained minds as well as skilled hands, and are students in one of the largest and best of colleges—the one that grants no degrees, issues no diplomas, and has no alumni, for no man worth his salt who has once enrolled as a student in the College of the Midnight Lamp, ever graduates.

In many other points this college differs from its sister educational institutions. It publishes no list of its faculty, yet on its teaching staff are many honored names, for it includes every man who publishes, in trade papers or elsewhere,

information of value and interest to any of its students. This college has no students entered in obedience to paternal mandate and supported by paternal checks. Its tuition fees are small and are paid from the students' daily earnings. Its pupils, at entrance, are often of mature age, with very definite ideas of what they wish to learn. They are men accustomed to daily labor, who have found that mere labor brings small returns of pleasure or profits, while the work of the skilled hand, directed by the trained mind, yields not only a fatter pay envelope, but the keen and lasting satisfaction of mental growth and accomplishment.

Some there are, as in all schools, who start bravely but soon fall out of the ranks, but there remain those in whom are the insatiable thirst for knowledge and the firm and steadfast resolution that will hold them unflinchingly to the arduous program of nightly study after daily toil. What are they studying? Most of those I have met have begun with some subject directly related to their daily work, but they do not stop when the first topic is mastered. The curriculum is wide, and as all courses are elective every student is free to follow his own tastes and inclinations.

One man, who hesitatingly took up geometry and trigonometry soon after completing his apprenticeship in the machine shop, followed on through higher mathematics, then, wishing to know more of the materials on which he worked, studied deeply the chemistry of steel, meanwhile "as a diversion," he says, acquiring a reading knowledge of three languages, and learning shorthand "to save time in keeping notebooks." It can hardly be charged that his devotion to study has seriously interfered with his regular work, for he has risen step by step to the head of the mechanical department of the corporation by which he has been employed for thirty years, and has lately received a year's leave of absence, that he may give to a similar concern in another country the benefit of his expert knowledge. This, of course, is an exceptional instance. What does the ordinary student gain? To what end does he employ in study the hours which others spend in amusement or in sleep?

While these questions can be only partially answered in terms of dollars and cents, the consciousness of increased knowledge and broader outlook being a large part of the compensation, still the effect on the pay envelope is of prime importance to all of us who earn our living by our trade. One often reads tales of men who have gained large increases of wages after taking a course in a correspondence school, and sometimes hears these ridiculed as extravagant, but I have yet to see one which I cannot duplicate from my own observation. The machinist who doubles his earning power in two short years is no figment of an ad. writer's vivid imagination. I've seen it done. Does what he learns lead to his advancement? Not that alone, but study added to the unrelaxing bulldog strain in his make-up that led him to begin the study and kept him at it, and if his case seems unusual, it is only because most of us lack just that quality.

We often hear pessimistic talk of the decadence of our trade—that it is poorly paid, offers no future for a young man, etc., but it seems to me that it depends, mainly, on the young man himself. He may look enviously at those who are able to secure the well-rounded, symmetrical training which he thinks a properly equipped technical school bestows; he may regret his inability to spare even the moderate fees for a correspondence school course, but *if he has it in him* he can obtain all the education he wants, all the mental training he desires, almost without money cost, from the institution that has given us so many of our best men—the College of the Midnight Lamp.

New London, N. H. GUY H. GARDNER

POWER PRESS PUSH GUARDS

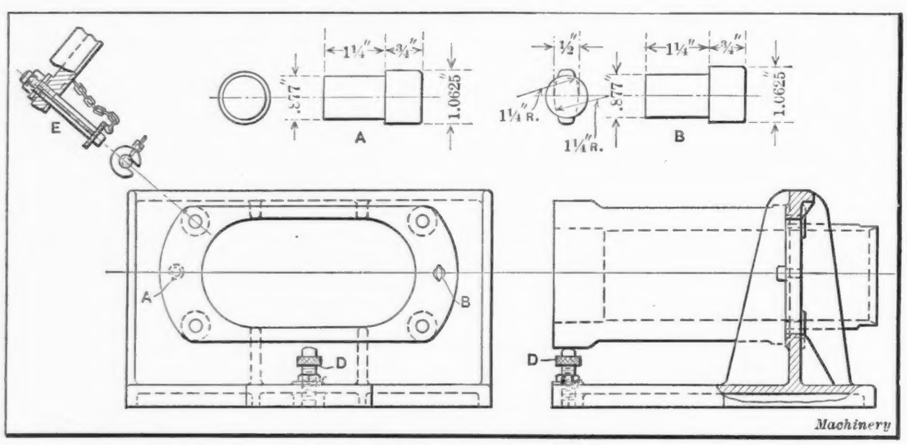
We noticed in the July number of MACHINERY, engineering edition, that credit was not given where credit is due. The so-called Hemphill push guard device for safeguarding a power punching press was exhibited by the Stiles & Parker Press Co. at the Centennial Exposition in Philadelphia in 1876. The E. W. Bliss Co., since buying the Stiles & Parker press business, has put a number of these devices on presses. Mr. Hemphill simply copied the Bliss device on a press fitted up for the Travelers' Insurance Co. by us in 1908.

We enclose a photograph showing this identical press from which he made his copy; also a photograph showing a cutting press made by us over twenty years ago for a Baltimore concern, on which the same device was applied.

Brooklyn, N. Y. E. W. BLISS CO.

GRINDING FIXTURE FOR HOLDING TWIN CYLINDERS

A grinding fixture for holding gasoline engine cylinders that are cast in pairs is illustrated herewith. This fixture was designed for a large internal grinder having a table equipped with an indexing cross-slide. As the movement of this cross-slide was sufficient for indexing from one cylinder bore to the other, it was possible to design a comparatively simple fixture, but owing to the size of the cylinders the fixture had to be very strong and rigid as well as easy to operate. The cylinder casting is shown in outline in the side view.



Grinding Fixture for Twin Cylinders

The cylinders are first bored and all other necessary machine work is done before grinding. The holes in the base are also drilled and reamed by a jig located from the two bores. The fixture is provided with two dowel pins *A* and *B*, one of which is round and the other oval. These pins fit into the reamed holes and accurately locate the cylinder in relation to the bores. Pin *B* is made oval (see also enlarged view) to avoid the binding which might occur in case both pins were round. In other words, with the oval pin the distance between the drilled holes can vary slightly, whereas if both pins were round and fitted the holes closely there might be trouble from center-to-center variations.

The jack-screw *D* which supports the outer ends of the cylinders is adjustable. The four bolts engaging the four holes in the base hold the cylinder firmly in position. These bolts, one of which is shown in detail at *E*, have keyways which engage tongues or keys on washers that are screwed to the back of the fixture. This arrangement prevents the bolts from turning when being tightened or released. The slip washers which form the heads are attached to the fixture by chains which prevents their being lost. When these washers are removed the bolts can, of course, be passed through the holes when inserting or removing work. M. W. W.

A DIAL COMPAROMETER

We recently came to the conclusion that the usual form of commercial indicators were not accurate enough for measuring such work as size blocks, plug gages, type and a variety

of other parts where great accuracy is essential, and to meet the requirements of such cases the indicator shown in Fig. 1 was designed. The case of this instrument measures about 2.75 inches in diameter, and the dial indicates 0.010 inch for one complete revolution of the pointer. The arrangement of the working parts is as follows: Lever *A* is 2 inches long from the fulcrum screw *B* to the pin *C*, and is 1/8 inch long from the screw *B* to the flange on the plunger *D*. This means that when plunger *D* is moved through 0.010 inch, the end of lever *A* in contact with the pin *C* moves through a distance of 0.160 inch, as the length of the lever from *B* to *C* is sixteen times the length from *B* to the flange on the plunger *D*. The segment gear *E* measures 1.125 inch from the pivot *F* to the pitch line, and the pinion *G* is 1/4-inch pitch diameter or 0.7854 inch in circumference. As it is desired to have one complete revolution of the pointer over the dial represent a movement of 0.010 inch of the plunger in contact with the work, the pin *C* must be located on the segment gear at such a distance from the pivot *F* that this movement of 0.010 inch of the contact point will produce a movement of 0.7854 inch at the pitch line of the segment gear *E*. This, in turn, will cause the pinion *G* to make one complete revolution.

Fig. 2 shows the method of arriving at the result. We know from geometry that corresponding sides of similar triangles

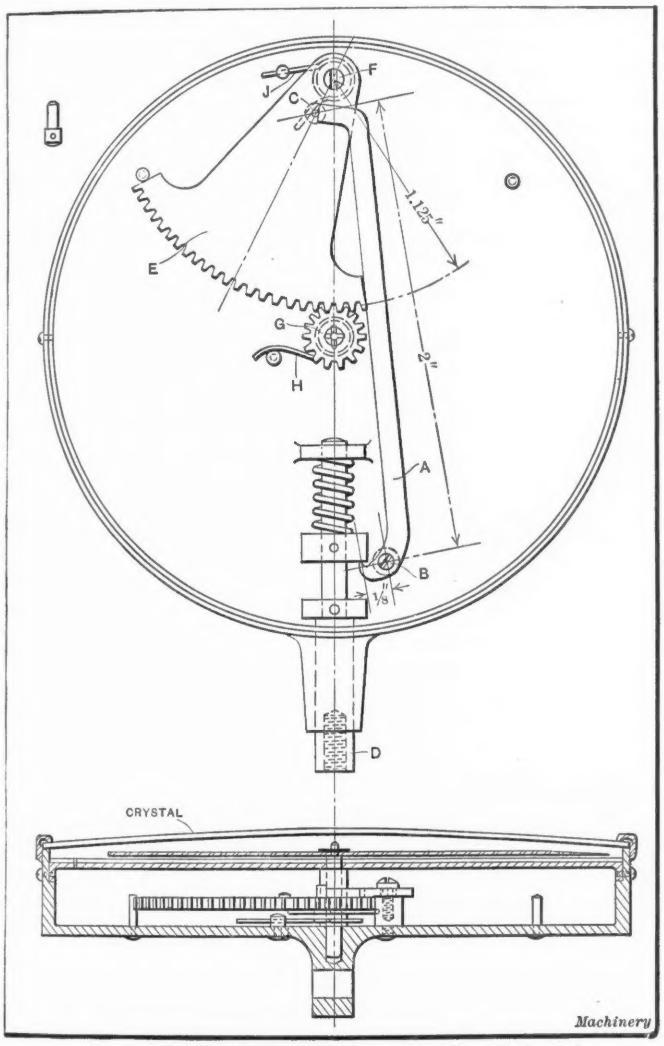


Fig. 1. Dial Comparometer for measuring Size Blocks and Other very Accurate Work

are proportional to each other, and applying this principle to the present case, we have:

$$\frac{FC}{0.160} = \frac{1.125}{0.7854}$$

$$FC = \frac{0.160 \times 1.125}{0.7854} = 0.229 \text{ inch.}$$

In Fig. 2, *F* and *C* represent the pivot on which the segment gear is carried, and the contact point of the lever *A*, respectively. The value 0.229 inch represents the distance at which the pin *C* must be located on the pivot *F*. The dial of the instrument is graduated to 100 equal parts, each of which represents 0.0001 inch. The spaces between consecutive graduations are sufficiently large so that half and quarter spaces may be readily estimated. This instrument is very sensitive and is practically "fool proof" as far as breaking the mechanism by forcing in the plunger *D* is concerned. It will be seen that two small pins are provided to limit the movement of the segment gear *E* in either direction. The pinion is always in mesh with one side of the teeth on the segment gear owing to the action of the hair spring *H*.

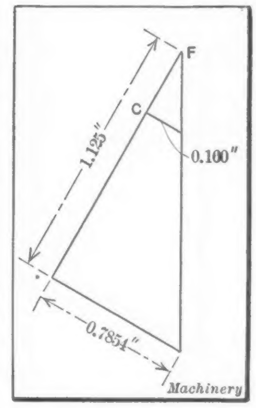


Fig. 2. Method of computing Required Leverage

The operation of the comparometer may be briefly described as follows: A movement of the contact point on the work moves the plunger *D*, and the flange on this plunger moves the short end of the lever *A* with which it is kept in contact by the action of a spring *J* on the segment gear and the spiral spring on the plunger. In this way a uniform contact is maintained between the long end of the lever *A* and the pin *C*, and also between the flange on the plunger and the short end of the lever *A*. The movement of the lever *A* in contact with the pin *C* causes the required movement of the segment gear which turns the pinion and the pointer that is carried on its shaft. The operation of this indicator is absolutely smooth, there being no tendency for the pointer to "hesitate" or "jump."

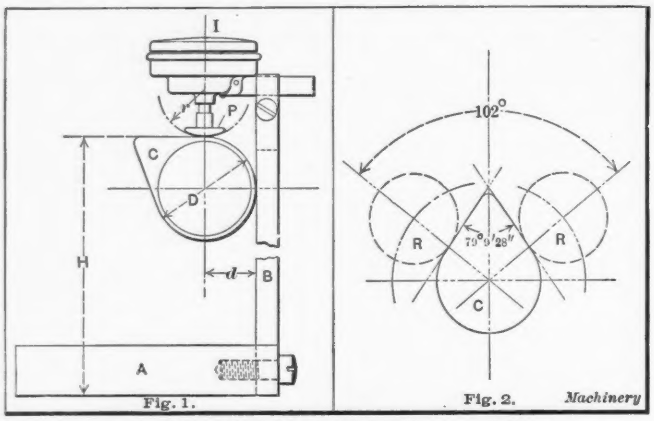
New Britain, Conn. W. C. BETZ

CHECKING A CAMSHAFT WITH THE DIAL INDICATOR

Whether or not a camshaft, made from a carefully planned design, will perform just what it is intended to do may remain a matter of uncertainty until it is tried out. Of this much, however, we are assured: if after a careful checking it meets all predetermined conditions every one interested is relieved. With a new design it is not always possible or convenient to make an actual test on a motor, and any method that makes it possible to accurately check up the vital points of the camshaft will be welcome. As the measurements for length, diameter, etc., are easily made with regular tools, this article will be confined to a method of measuring the relation of the opening and closing points of the cams, with reference to some starting point as, for instance, the keyway for the camshaft gear.

Fig. 1 shows a stand of simple construction, which was made to carry a Starrett dial indicator. Its design could have been elaborated by providing vertical and lateral adjustments, but these were unnecessary. The base *A* is made sufficiently heavy to stand firmly, and the vertical support *B* is notched into the base and secured by screws. The upper end of the support is drilled and reamed to receive the shank of the indicator *I*, and also split and provided with a screw to clamp the shank. The indicator contact point *P* is a spherical segment whose radius *r* is one-half the diameter of the cam roll. The center line of the indicator must stand in the same relation with the camshaft, as the roll would occupy in the motor, which in this case is on the center line of the camshaft. The distance *d* is then one-half of *D*, and the height *H* is such as to give a good contact between the point *P* and the cam *C* and allow the full limit of the indicator movement.

With the camshaft suitably dogged and mounted between the index centers, the first move would be to find the center of the keyway for the camshaft gear, as the probabilities are that the centers of the cams are laid out with reference to that center. Let us assume that we have our inlet cam shaped as shown in Figs. 1 and 2, and that the center of this cam coincides with the center line of the keyway; also that the opening and closing points are at the positions occupied by the cam rolls represented by the dotted circles *R* in Fig. 2. The actual opening and closing points are then one-half of 102 degrees, or 51 degrees in advance and 51 de-



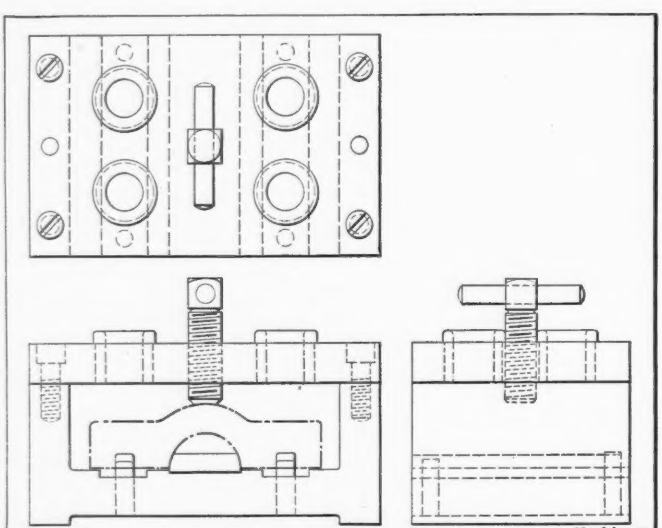
Figs. 1 and 2. Stand for the Dial Indicator and Diagram showing Method of Procedure

grees back of the starting point. With the indicator set on the dwell of the cam, allowing for a rise of 0.003 inch (the clearance under the valve stem) before zero, and with the indicator in the position shown, we index the camshaft around to the correct angle. If the work has been accurately done, the indicator needle should just begin to rise at that 51-degree angle; if not, it will rise either too soon or too late and the amount of error is read from the index circle. The relation of all the other cams to the keyway is checked in similar manner, taking all inlet points in their firing order and then all closing points. The amount of error found, in spite of very careful workmanship, is sometimes surprising, even when measurements with micrometers and a protractor show up well; but, thanks to that highly useful instrument, the indicator, many things in our line are being reduced to a degree of accuracy approaching perfection.

Hartford, Conn. ERNEST A. RUNGE

DESIGNING JIGS AND FIXTURES

The simple form of drill jig shown in the accompanying illustration, which is for a small bearing cap, illustrates a very good method of designing jigs and special fixtures. The part for which a jig is required is first laid out, and thus the



Drill Jig used to illustrate Method of designing Jigs and Fixtures

jig is designed by working around this lay-out. The part should preferably be drawn in red, green or some other light colored ink, and one or more views should be shown, as this will give a clearer idea of its shape and size and will be a help in determining the best and most accurate method of handling work. This method is particularly helpful in designing jigs for complicated parts. By drawing the work on the tracing with some light colored ink, then drawing the jig and dimension lines with black ink, the blueprint will show the distinction between the work and jig very plainly. The jig and dimension lines show on the print in bold, white lines while the work is in light, pale lines. This method is a great help to the patternmaker in working out the pattern for the jig or fixture because he can more readily understand the jig drawing. When the drawing is arranged in this way, it is also helpful to the toolmaker because he can not only understand the drawing better but also has a clearer idea of the parts which require the most accuracy. M. W. W.

[In the illustration, the work is indicated by dot-and-dash lines in the usual manner, as the pale lines on the original blueprint cannot be reproduced.—EDITOR.]

IDEAL DRAWER BOTTOM

Some time ago we had occasion to build several cabinets for filing tracings and pencil sketches. The drawers were 26½ by 38½ inches in size and were used without partitions for storing our largest size drawings which were 24 by 36 inches. Some of the drawers were divided up with partitions as shown in Fig. 2 to accommodate drawings 18 by 24, 12 by 18, 9 by 12 and 6 by 9 inches in size. The partitions were made of ½-inch stock. Upson wall board was found to constitute an ideal bottom for the drawers. This material is about 3/16 inch thick and can be bought in sheets large enough to make the entire bottom of the drawer from a single piece, thus eliminating cracks or joints. A further advantage is that the material has no tendency to shrink or warp out of shape. It is flat and stiff enough to require little reinforcement, and is considerably lighter than wood. In making the drawers, a groove was cut in each of the four sides to receive the edges of the wall board, and a small wood strip, ½ by 1 inch in size, was fastened across the center of the drawer on the under side of the wall board to act as a reinforcement. These cabinets have now been in use for nearly a year and are still in perfect condition.

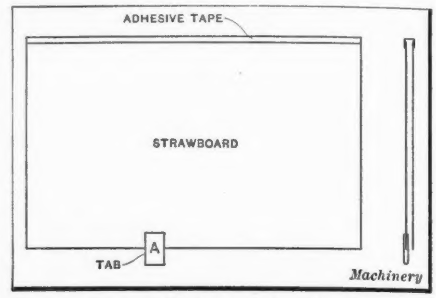


Fig. 1. Type of Binder used for filing Drawings

Pencil sketches are filed in these cabinets in alphabetical order, and owing to an insufficient number of drawers it was necessary to file the sketches coming under several index letters in the same drawer. In order to keep the drawings of different index letters separate, binders were made for each letter in all of the different sizes. These binders were made of two pieces of No. 50 strawboard, fastened together on the side which is placed toward the back of the drawer. Adhesive cloth tape is used for this purpose, the method being clearly shown in Fig. 1. It will also be seen from this illustration that a tab of this cloth tape is fastened to the front

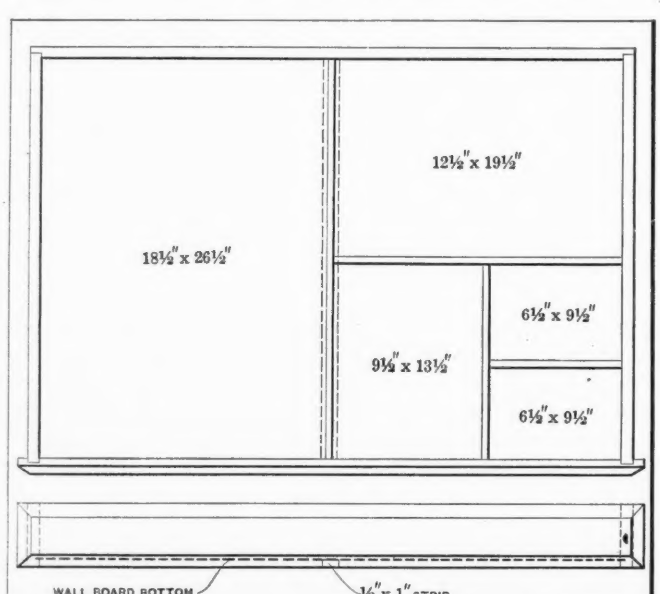


Fig. 2. Design of Drawer equipped with Upson Wall Board Bottom

of the top sheet of the binder, the proper index letter being marked on this tab. This arrangement makes it possible to locate any required binder promptly and the tab can also be used to lift the cover. These binders not only separate the drawings of different classes, but also prevent sketches from working out at the back of the drawers.

Aurora, Ill. E. J. G. PHILLIPS

SPRING STRIPPER PUNCH AND DIE

The punch and die illustrated in Fig. 2 was designed for punching five holes in the piece shown in Fig. 1. Owing to somewhat unusual conditions in gaging the work in this die, a spring stripper was found most satisfactory. Referring to the illustration, the stripper will be seen at *A*. It is operated by springs supported by the bolster *B*.

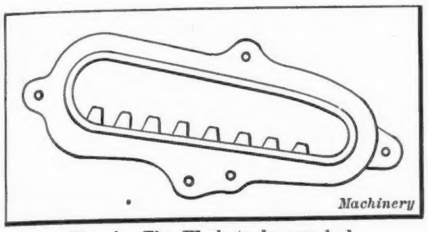


Fig. 1. The Work to be punched

The first step in designing the die was to determine the number of springs required to operate the stripper. The holes to be punched are 1/2 inch in diameter and the thickness of the work 3/8 inch, the material being malleable iron. A test was conducted by forcing a 1/2-inch punch through a 3/8-inch malleable iron plate, stopping the press at the bottom of the stroke and releasing the punch so that it could be removed with the plate. The plate and punch were then taken to a Riehle testing machine and it was found that a force of 1200 pounds was necessary to pull the punch out. It was obvious, then, that a force of 6000 pounds was necessary to strip the work off five punches.

It was decided to use springs coiled from wire 5/16 inch in diameter, the diameter of the coils being 1 1/4 inch. Referring to the table in MACHINERY'S Handbook, giving the maximum load in pounds which different sizes of helical springs will carry, it is found that the load that can be supported by springs of this size is 1220 pounds. Allowing a factor of safety of 1 1/2—as the springs are not subjected to severe vibration—the total load used in calculating is $1.5 \times 6000 = 9000$ pounds. The number of springs required is then found to be $9000 \div 1220 = 7.35$. Using the next higher number, we find that eight springs are necessary. Four of the springs are held between the stripper *A* and bolster *B* by means of bolts *C* and the other four springs are secured by pins entering into the ends of the springs. One of these pins is shown at *D* in Fig. 2. Two 1 1/4-inch guide pins line up the die.

Each coil of a spring of the size used for the stripper may be compressed 0.138 inch. Allowing 5 inches between the stripper and the bolster, there will be sufficient room for springs with eight coils. The total allowable compression of these springs will be $8 \times 0.138 = 1.104$ inch. The stroke of the press is 2 inches and allowing the stripper to act through the last 1 1/16 inch of the stroke, the required pressure will be secured to strip the work from the punches.

Hamilton, Canada J. M. HARRISON

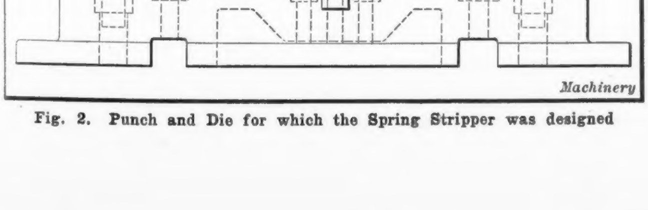
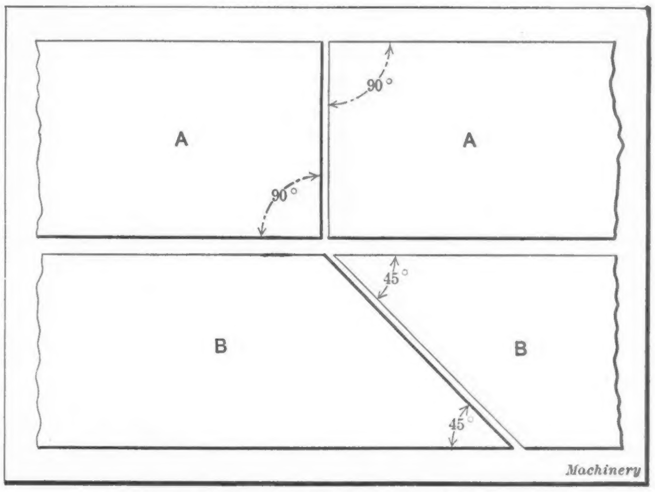


Fig. 2. Punch and Die for which the Spring Stripper was designed



Leather Belts laced at Angles of 45 and 90 Degrees

LACING LEATHER BELTING

It is a time-honored custom in splicing leather belting to cut the ends of the belt which are to be laced together so that the splice makes an angle of 90 degrees with the edge of the belt. This method is shown at *A* in the accompanying illustration. Anyone who has had much to do with the maintenance of belting knows that the rawhide laces wear and pull out long before the belt is worn out. The use of steel lacing does not eliminate the difficulty, because the holes in the belt finally become so large that the splice pulls apart.

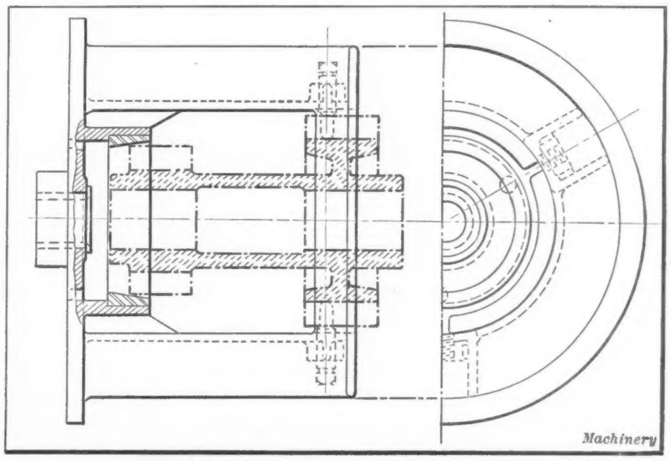
If the belt is spliced at an angle of 45 degrees, as shown at *B*, and laced in the usual manner, it will be found that the lacing will last fully as long as the belt. This is due to the fact that with the belt cut at a 45-degree angle, there are more strands of the lacing for a given width of belt, and the strain of the lacing in the holes is distributed over a greater distance than when the belt is cut in the usual manner.

East Orange, N. J. GEORGE GARRISON

[Mr. Garrison has used this method of splicing belts in certain classes of work, and finds the results entirely satisfactory. We have never seen this method used before and it appears that the practice of making the splice on an angle might have a tendency to cause the belt to run off the pulley. If other readers of MACHINERY have used this method, we should be pleased to hear of their experience.—EDITOR.]

CHUCK FOR TWIN SPUR GEARS

The chuck illustrated herewith was designed to produce more gears on a large turret lathe than were being produced



Special Chuck for holding Twin Spur Gears while boring Hub

on the same lathe equipped with a regular chuck having special jaws and clamps. This new chuck was also designed to insure greater accuracy. The dot-and-dash lines show the twin spur gears in place in the chuck. These gears are of cast steel and have one long hub, the bore of which must be accurate in relation to the teeth. The chuck has a finished boss that fits into the faceplate of the lathe and this boss is provided with a bushing for guiding the pilot of the turret

boring-bars, thus making the chuck and bars accurate in relation to each other.

The back of the chuck contains a taper ring of casehardened steel, which forms an accurate centering device for the smallest of the two gears, the gear being centered by the outside of the teeth. The larger gear, which has a number of teeth divisible by 3, is set centrally in the chuck by adjusting three screws that engage the bottoms of the teeth. These screws provide a means for locating the gears centrally, and also act as drivers. The chuck is of light construction and is well ribbed. The projecting ring and ribs not only strengthen the chuck but serve as guards to prevent the screw heads from injuring the lathe operator. As the guard ring is only a trifle larger than the gear, it is of value to the operator in judging the position of the gear when centering it.

M. W. W.

DESIGN OF SHEAR FOR CUTTING ANGLE IRONS

I was particularly interested in reading the answers to J. D. Y.'s inquiry in regard to the design of shear blades for cutting angle irons, which have been published in MACHINERY. I have had quite a little experience along this line and would like to add a suggestion in regard to the best method of handling this class of work. Three or four years ago I received orders to make a shear for cutting angle irons, the chief requirement being that it would be capable of cutting the pieces off square and free from burrs. I made a shear

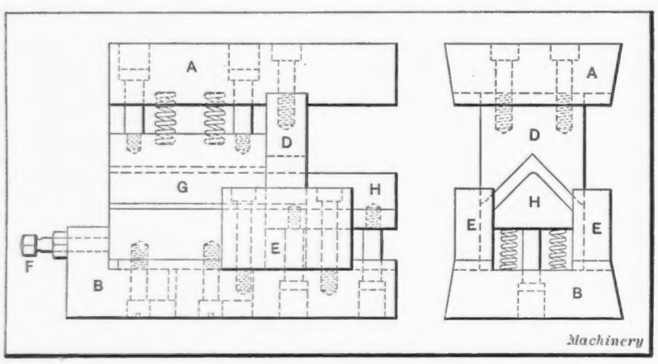


Fig. 1. Side and End Views of Shear for cutting Angle Irons

somewhat similar to the one described by J. M. Henry and tried it out. The first lot of angle irons was cut fairly well and I thought that the problem had been solved very satisfactorily, but the next lot of stock that came in was much softer and when we started to cut it up our troubles began. I tried all sorts of remedies but found it impossible to get satisfactory results until I finally hit upon the scheme of making a pair of shear blades equipped with spring pads. An equipment of this kind is illustrated in Figs. 1 and 2, from which the design will be readily understood.

Referring to Fig. 1, the upper and lower blocks upon which the shear blades are mounted are shown at *A* and *B*, respectively. The lower blade *C* is made of tool steel and formed to the shape of the inside of the angle iron. The upper blade *D* which is also made of tool steel is machined to the same angle as the outside of the angle iron. The lower block *B*, which is shown in Fig. 2, has a longitudinal slot cut in it to receive the blade *C* and a transverse slot to receive the backing up pieces *E* which support the upper blade. The block *B* also has holes machined in it to receive the screws for holding the shear blade in place, these holes being elongated so that the blade may be adjusted by means of the screw *F* to compensate for the effect of grinding.

The backing up pieces *E* fit snugly against the upper blade and are fastened to the block *B* by two fillister-head screws and a dowel pin. The spring pad for the upper blade is marked *G*, and *H* is the spring pad carried by the lower blade. These pads are held by two shoulder screws and each pad has four springs under it. The function of the pads is to hold the stock so that it cannot move lengthwise while being cut. The pad *G* extends 1/4 inch below the edge of the upper blade so that when the ram descends, the pad grips the angle iron before the blade comes into action. As the ram continues its downward stroke, the blade slides into the grooves in the side blocks *E* which makes it impossible for the upper and lower blades to separate.

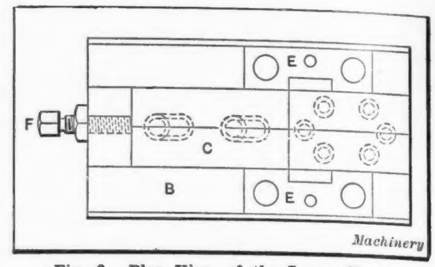


Fig. 2. Plan View of the Lower Shear

A shear of this kind may be made to cut all sizes of angle iron from 1/2 up to 2 inches. This shear is used in a punch press and has been in operation for about three years. Aside from replacing the blades when they become worn out, it has given practically no trouble. Of course the first cost of this shear will be higher than that of an ordinary shear of the type described in previous contributions, but where it is absolutely necessary to cut angle irons without leaving any burrs, it will soon pay for itself.

Chicago, Ill. A. H. WILSON

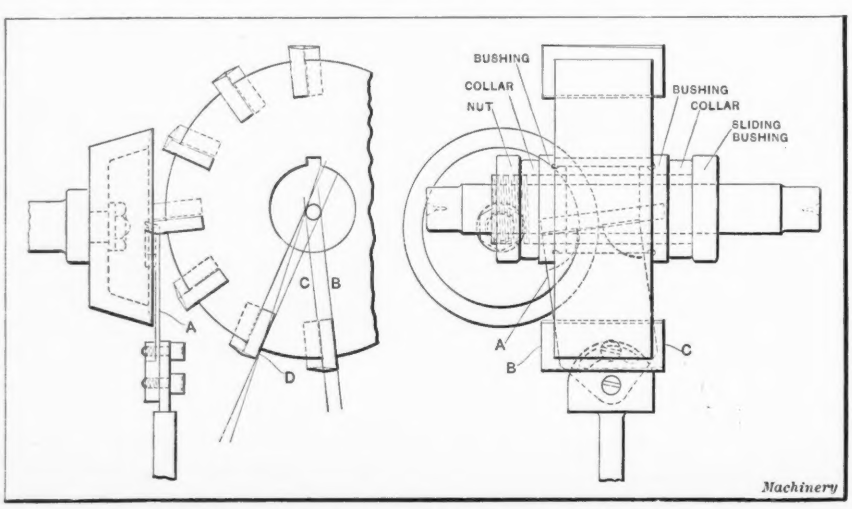
METHOD OF CUTTING PLATE GLASS

Among the numerous odd jobs met with in the general machine shop, there are few so "ticklish" as that of cutting plate glass where it is required to have the edges perfectly smooth and straight. If this work is attempted with the aid of a diamond glass cutter and rule, the glass will break with a ragged edge. The best method of overcoming this difficulty is described in the following: I have used it in cutting plate glass as thick as 1/2 inch and obtained excellent results. First obtain a good diamond glass cutter, and with this tool scratch the glass along the line on which it is to be cut, using any good straightedge to guide the diamond. In this connection it may be mentioned that the deeper the cut the more uniform the surfaces of the cut edge will be. After laying the glass on a cold surface with the cut side up, for which purpose the surface plate is very satisfactory, an iron or steel rod about 1/4 inch in diameter is heated to a dull red. This rod is then laid along the line scratched by the diamond point and pressed lightly against the glass. When held in position for from one to four minutes—depending on the thickness of the glass—it will be found that the glass will crack along the line, leaving a perfectly uniform surface.

JULIUS R. HANSEN

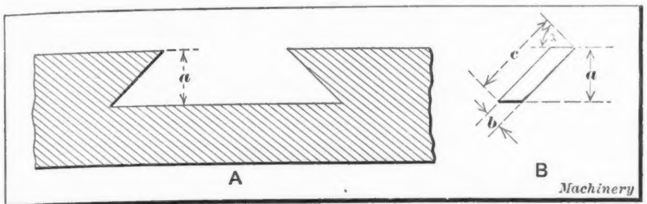
FIXTURE FOR GRINDING INSERTED-TOOTH CUTTERS

The accompanying illustration shows a fixture that has proved itself a great time-saver in grinding milling cutters



Tool Grinder Fixture for sharpening Angular Inserted-tooth Cutters

with inserted angular blades. The cutter to be ground is held on a sliding bushing which is carried on a straight mandrel mounted between centers on the grinding machine. This arrangement has been used for years in grinding spiral and straight milling cutters, but it is not suitable for grinding cutters with angular inserted blades without the use of the rest *A*. This rest holds the cutting edge of the blade at exactly the same height at both ends and gives excellent results on both angular and straight inserted-blade cutters.



Dimensions of Slide and Gib that should be given

The rest may be set to the desired angle for holding different cutters.

It will be noticed that the line *B* of the face of the blade has "drag" because it points ahead of the center, and that line *C* at the opposite side of the cutter has "rake" because it points back of the center. If it were attempted to grind an angular cutter with the blade supported on an ordinary rest at *D*, it will be seen that the blade would be at different heights on the emery wheel as it slides across the rest.

Franklin, Pa. FRED R. IRWIN

PROPER DIMENSIONS FOR A GIB

In the April number of MACHINERY, W. Butz invites a discussion in regard to the proper method of dimensioning a gib. As it seems to be a question of the necessary dimensions for both the required size of the stock and the gib to be machined from it, the writer believes that none of the three methods shown by Mr. Butz is entirely satisfactory. In dimensioning the slide *A*, one would naturally give the dimension *a*. The same dimension *a* should be given on the gib *B*. This dimension *a*, together with the proportions *b* and *c* and the angle *a*, should be given. Where the gib is proportioned in this way, and the required length of the gib is specified, the machinist has complete information and can proceed with the machining operations.

Whitinsville, Mass. S. H. HELLAND

DRILLED AND PUNCHED HOLES FOR A. S. M. E. STANDARD SCREWS

The accompanying table is taken from my note-book and gives the sizes of tap drills which have been found to give satisfactory results when drilling for A. S. M. E. standard tapped holes in various metals. In cases when it is desired to punch the hole, either for tapping size or for the body size —as in the case of sheet metal work—this table also gives the diameter to which it has been found the punches should be made in order to give satisfactory results. Designers who may have jigs to lay out or punch press tools to design where these sizes are called into play will find that the data presented in this table gives excellent results without involving much expenditure for the replacement of taps which break if too much stock is left for tapping.

Hartford, Conn. C. F. SCRIBNER

SIZES OF DRILLED AND PUNCHED HOLES FOR A. S. M. E. STANDARD SCREWS

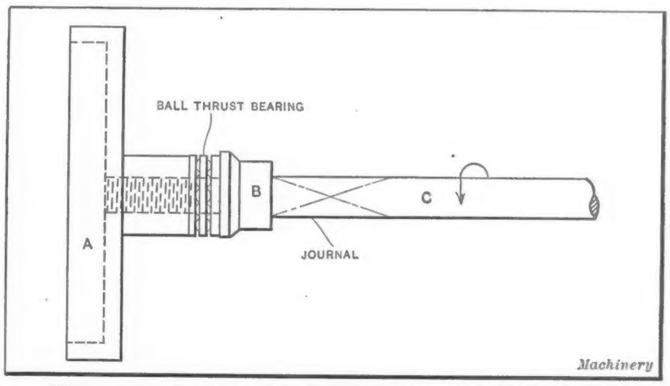
Number	Threads per Inch	Outside Diameter		Pitch Diameter		Root Diameter		Tap Drill Sizes				Body Drill, No.	Diameter of Punches	
		Maximum, Inches	Minimum, Inches	Maximum, Inches	Minimum, Inches	Maximum, Inches	Minimum, Inches	Steel, No.	Brass, No.	Cast Iron, No.	White Metal, No.		Tap, Inches	Body, Inches
0	80	0.060	0.057	0.0519	0.0505	0.0438	0.0410	..	..	..	..	52	.....	0.063
1	72	0.073	0.070	0.064	0.0625	0.0550	0.0520	..	..	..	..	48	.....	0.075
2	64	0.086	0.083	0.0759	0.0743	0.0657	0.0624	49	49	49	49	43	0.069	0.088
3	56	0.099	0.096	0.0874	0.0857	0.0758	0.0721	44	45	45	45	38	0.085	0.101
4	48	0.112	0.108	0.0985	0.0966	0.0849	0.0807	40	42	42	42	33	0.097	0.112
5	40	0.125	0.121	0.1102	0.1082	0.0955	0.0910	36	38	38	38	30	0.110	0.127
6	36	0.138	0.134	0.1218	0.1197	0.1055	0.1007	32	34	34	34	28	0.115	0.139
8	36	0.164	0.160	0.146	0.1438	0.1279	0.1227	28	29	29	29	19	0.139	0.164
10	32	0.190	0.185	0.1684	0.166	0.1467	0.1407	20	22	22	22	11	0.161	0.191
12	28	0.216	0.211	0.1928	0.1904	0.1696	0.1633	13	15	15	15	2	0.185	0.219

Machinery

A BALL BEARING APPLICATION

Part of a certain special machine is shown in the accompanying illustration. The mandrel shaft *C* carries the collar *B*, which is shrunk on against a shoulder. A left-hand threaded stem extends beyond the collar, and on this threaded stem there is a cast-iron flange *A*. Formerly this flange screwed up to the collar, and the nature of the work tightened the flange against the collar, which, in addition to the close fit of the long thread, made removal difficult. Sometimes the flange had to be removed after running two hours, and sometimes it was left on for a week; but it was always difficult to unscrew. The mandrel would have to be blocked and a pipe wrench applied to the hub of the flange in order to unscrew it; this usually required two men.

The writer was asked to remedy the trouble. An entirely different construction seemed to be the best remedy, but this was not feasible at the time. Naturally, knock-off arbors were thought of, but were rejected as being too complicated and too delicate for the rough unskilled labor which operated the machine. We had in our stock-room different sizes of standard ball thrust collar bearings. One of these was secured between the flange hub and the collar on the mandrel, as the illustration shows. With this bearing in place, the flange unscrewed as easily as it went on, and twirling it on with a "bang," made no difference; neither would a week's service, as it always came off readily. And curious to relate, there was no tendency for the flange to unscrew of itself, even though it was screwed on lightly and the machine run "light."



Flange screwed against Ball Thrust Bearing to facilitate Removal

Middletown, N. Y. DONALD A. HAMPSON

RELIEVING TAPS BY HAND

Having had an experience of some forty years in making and using taps, it seems to me that a tap relieved by hand with a file will work easier and last longer than a machine-relieved tap. A tap must be beveled at the end for several threads so that it will start into a hole, and, of course, it must be relieved on top of the beveled part. The first tooth to cut in starting cuts the whole width of the bottom of a V-thread; the next following tooth a little deeper, the next still deeper and so on until the full depth is attained, and all the cutting is done by the beveled or leading part of the tap.

My way of relieving a tap is to use a three-cornered file, the teeth of which are ground off on one side so they will not cut at all. I file the front side of the thread or tooth so it will be thinner at the back or away from the cutting side of the tooth. The front side is filed nearly up to the cutting edge, the smooth side of the file being held against the back of the tooth. When a tap is relieved in this way the front side of the thread will do all the cutting and the back will be smooth, just as the lathe tool left it, and the tap will cut freely and easily.

Of course I am aware that nearly all shops buy their taps now, but I have seldom seen taps that would work so freely and last so long as those relieved as described in the foregoing. Relieving both sides of the thread or tooth is not only unnecessary, but harmful, as the tap is more likely to chatter and cut a poor thread. It would probably be difficult to machine-relieve the thread on only one side, but I am convinced that taps relieved in that way are much more satisfactory.

Cleveland, Ohio S. S. Jennison

MAKING TUBING FROM HEAVY STOCK

The illustrations presented in this connection show two dies used for making a tube out of heavy stock. The method of using these dies is as follows: A ¼-inch plate of cold-rolled steel is placed in position on the die shown in Fig. 1, and

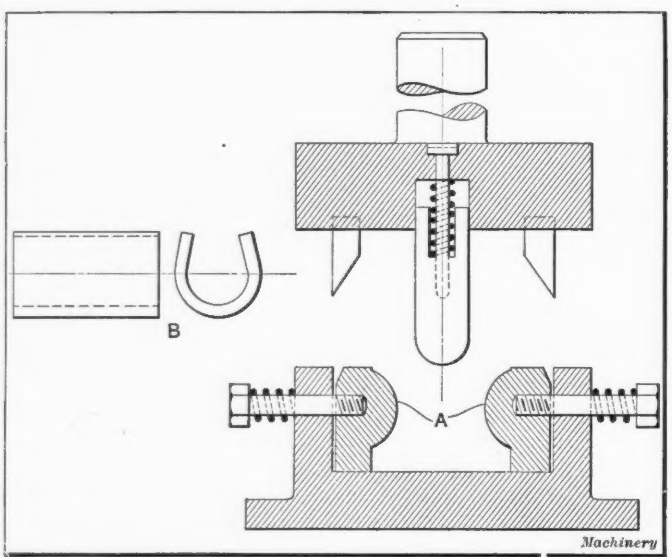


Fig. 1. Novel Punch and Die for performing the First Operation

when the punch descends it forces this plate to the bottom of the die, bending it between the surfaces *A*. The punch-holder and cams continue their downward movement, and the cams force the two surfaces *A* in, thus bending the work to the form shown at *B*. The work is next transferred to the die shown in Fig. 2, which closes it up to form a tube.

Milwaukee, Wis. W. Butzlaff

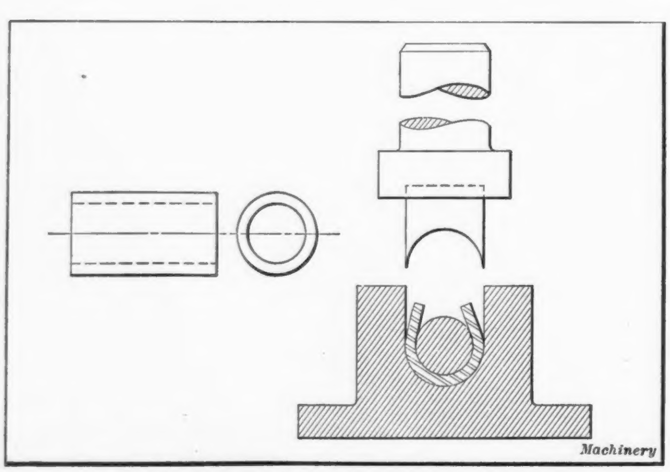


Fig. 2. Punch and Die for closing up the Tube

TWO LATHE TOOLS

Two useful forms of lathe tools are shown in the accompanying illustrations. The tool illustrated in Fig. 1 is either used in the tailstock of the lathe or placed in position against the work and supported by the tail-center at *A*. When using a lathe with badly worn spindle bearings, the use of this tool does away with the tendency toward vibration and at the same time takes up end play. For the purpose of description, let us suppose that a large casting or forging is held in the chuck of such a lathe in order to be turned and faced. The face *B* is brought up against the work, upon which it secures

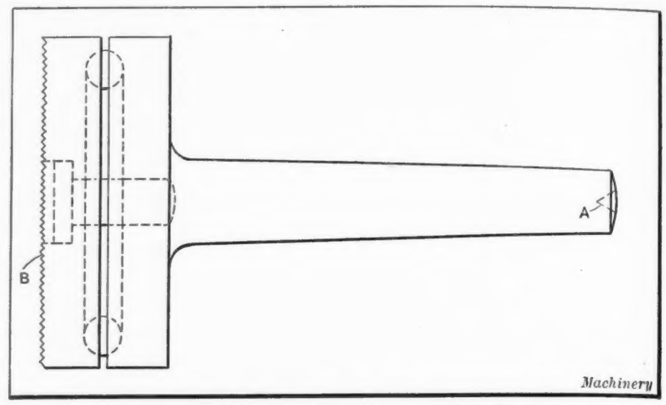


Fig. 1. Auxiliary Tailstock for supporting Work in a Lathe with Worn Spindle Bearings

a firm grip by means of the knurled surface. The support provided in this way prevents the lathe tool from digging into the work and thus produces a much better finish than would otherwise be obtained. It will be seen that the tool consists of two revolving disks which have races machined in them to carry ball bearings. The right-hand disk has a taper shank which fits the lathe tailstock. The knurled disk which engages with the work is hardened and held in position by means of a fillister head screw.

The tool shown in Fig. 2 is a micrometer stop that is used to eliminate all guesswork when boring a recess in a piece held in the lathe chuck. For instance, suppose it is desired to bore out a hole three inches deep. After roughing out the hole to approximately the required depth, the stop is placed in position on the lathe bed near the headstock and the carriage brought up to it. The stop is clamped to the lathe bed by means of a C-clamp. The next step is to take a light cut on the bottom of the hole or recess in the work, after which an accurate measurement of the depth is made. By subtracting

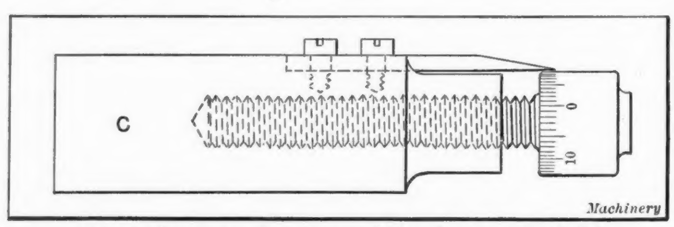


Fig. 2. Micrometer Stop for regulating Depth of Final Cut

this measurement from the required depth, the number of thousandths of an inch that must still be bored out is determined. The micrometer screw is then used to set the stop for the required depth, after which the tool can be fed into the work until the carriage engages the stop. This does away with all cut-and-try methods and increases the accuracy and rapidity with which the operation can be performed.

Brooklyn, N. Y. Edward Rantsch

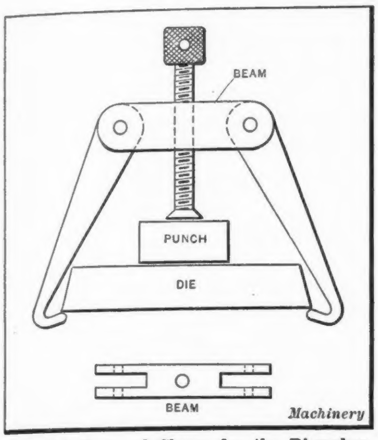
* * *

The imports of machinery to Germany during 1913 exceeded the imports during 1912 by 10 per cent. The exports during 1913 also exceeded the exports during 1912 by about 10 per cent. The total imports during 1913 amounted to 87,902 tons and the total exports to 593,969 tons. Of the imports, 40 per cent came from the United States, and 34 per cent from Great Britain. The exports were mainly to Russia, Austria-Hungary, France and Great Britain.

SHOP AND DRAFTING ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

DIEMAKERS' CLAMP



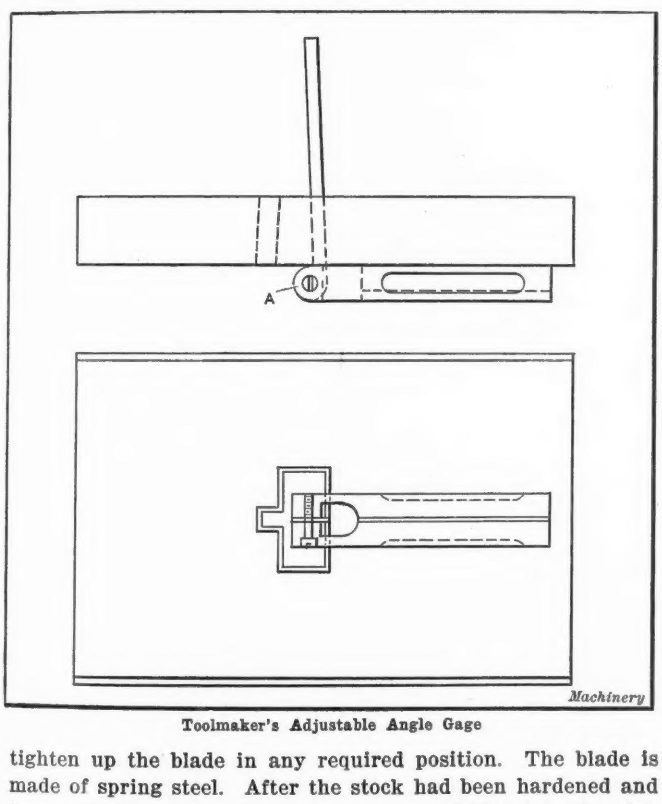
A Useful Form of Clamp for the Diemaker

The accompanying illustration shows a convenient form of diemaker's clamp. This tool is especially useful in transferring the shape of the hole in a blanking die onto the piece of steel from which the punch is to be made. The use of this device practically eliminates the chance of the punch slipping, when scribing its outline on the die, which would result in an inaccurate layout.

Upper Hamilton, Ontario, Canada. H. GROVES

ADJUSTABLE ANGLE GAGE

The accompanying illustration shows a useful form of adjustable angle gage which has several advantages over any other design that I have seen. The only drawback is that this form of tool takes longer to make than other types which are in general use. It will be seen from the illustration that the stock has a slot machined in it which is deep enough to enable the blade to lie flush with the upper surface when the tool is folded up. The hole in the stock must be made large enough and the sides thin enough to enable the screw to tighten up the blade in any required position. The blade is made of spring steel. After the stock had been hardened and tempered, the blade was put in place and folded into the slot. The stock was then ground on all sides, a magnetic chuck being used for this purpose.



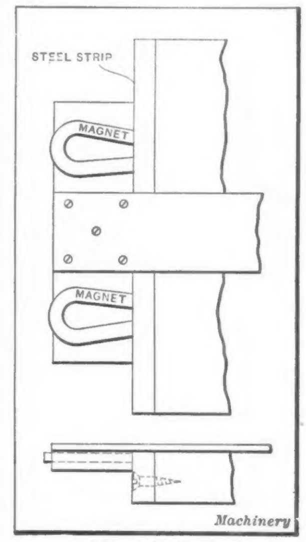
Toolmaker's Adjustable Angle Gage

It will be found convenient to have the end of the stock graduated at *A* and to have an index mark on the blade so that any required angular setting may be obtained. The chief features of the design are that the gage is adjustable and that the hole through the stock enables a toolmaker to see right along the blade when he is using the gage in small holes. The blade is also held square with the stock so that the gage may be used with the blade edgewise in narrow holes. The making of this gage will naturally depend upon the ability of the toolmaker and the appliances which are at his disposal.

Meriden, Conn. JAMES GALLIMORE

MAKING THE T-SQUARE STICK

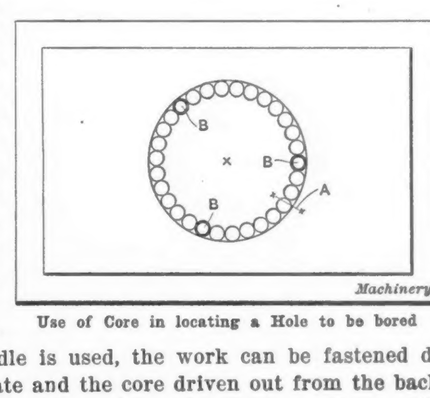
The article "Adjustable Clamps for T-square" by Murray Fahnestock, in the March number of MACHINERY, brings to mind an arrangement used in the drafting-room of the Stockbridge Machine Co., Worcester, Mass. The illustration explains the device, which is a magnetic arrangement for keeping the T-square in place against the edge of the drawing-board. This is especially to be desired when the T-square is to be used in one position for a considerable length of time. The head is mortised so that two ordinary horseshoe magnets can be securely held in it. On the edge of the drawing-board is screwed a steel strip against which the T-square bears. Thus the magnets, and consequently the T-square members, always have an attraction for the end of the drawing-board. While this device is very simple, it has worked out effectively. C. L. L.



A Magnetic T-square

LOCATING A HOLE TO BE BORED

It is sometimes more convenient to drill out the core of a large hole in a die or other piece of work than it is to drill and bore the hole in a lathe. When the core is removed by drilling, it may be conveniently relocated in the hole prior to setting up the work for finish-machining the hole. When this method is to be followed, a center punch mark is made at the center of the core, and a "witness line" *A* is scribed on the work, as shown in the accompanying illustration. After the core has been separated from the block, three drill rod pins of the same size as the drill used for making the holes are driven between the block and the core, as shown at *B*. The block is next mounted on parallels a little higher than the thickness of the block and fastened to the lathe faceplate, where it is accurately located with a center test indicator. The core is then driven out of the block from the front—the space between the work and the faceplate provided by the parallels making this possible—or when a lathe with a hollow spindle is used, the work can be fastened directly to the faceplate and the core driven out from the back. The same method can be used to advantage on pieces with irregular shaped holes that can be finished in a lathe, provided, of course, that the hole is large enough to enable the tool to clear all surfaces except the curve being bored.



Use of Core in locating a Hole to be bored

New Britain, Conn. W. C. BETZ

* * *

The Westinghouse strike at East Pittsburg, Pa., was called off by the workmen July 9, and the day set for return to work was July 13, but a large number of the men reported on the Friday and Saturday preceding. The works are now running full time.

TAPER BORING ATTACHMENT FOR THE TURRET LATHE

The cream separator bowl is full of headaches—for the producer. On account of the weight and thickness of the stock it is very hard to draw up, and as it must run very truly, it must be machined all over carefully.

At the plant of the King Sewing Machine Co., Buffalo, N. Y., which makes cream separators, as well as sewing machines, the bowls are finished very carefully, so that they will run at high speed and still be in balance. This requires that the inside of the bowl be machined perfectly concentric with the outside at all points, and for the purpose of finishing the inside of the tapered part of the bowl, as well as the straight part, the Warner & Swasey turret lathe is used, as shown

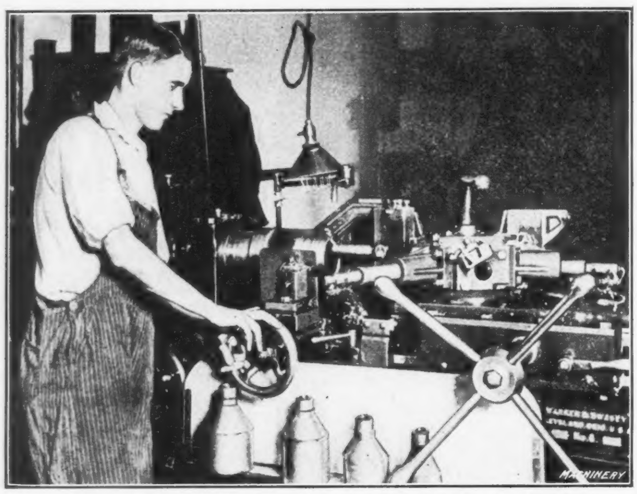


Fig. 1. Taper-boring Operation on Cream Separator Bowls

in the illustration Fig. 1. Fig. 2 shows the details of the taper-turning attachment, and Fig. 3 shows the cream separator bowl itself; in this illustration the surfaces that this taper-turning attachment machines on the inside of the bowl are indicated. It will be seen that the work done by this attachment consists of boring the straight section and then dropping to do the taper section with the same tool.

Referring now to the detail photograph, Fig. 2, the operation of the device may be seen. The tool itself is shown at *A*, being held on toolpost *B* that is made fast in the vertical tool-slide *C*. The tool-slide is fitted into a vertical bracket which is held on the face of the turret in the same manner as the other turret tools. At the upper part of vertical slide *C* is a roller mounted on stud *D*. This roller travels in a groove in the fixed bracket *E* at the rear of the machine. This groove is parallel with the line of turret travel for a short distance and then deflects downward on a taper of 36 degrees, to produce the required taper of the cream separator bowl. When the turret is brought forward for this operation, the cut continues parallel with the ways until the deflection in the slot on bracket *E* is reached. At this point the roll on stud *D* is

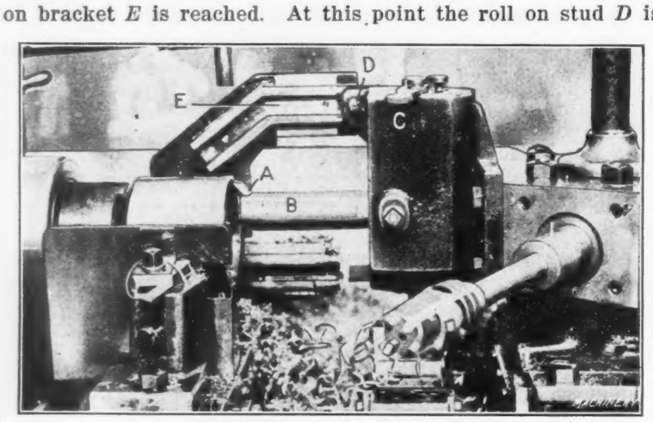


Fig. 2. Taper-boring Attachment

caused to travel downward as well as forward and carries with it the vertically moving slide *C* and also the toolpost *B* and the tool *A*. It should be noticed that tool *A* is sharpened at an angle which will be correct for cutting on the straight section as well as the inclined section. C. L. L.

HEAT-TREATING CASEHARDENED CARBON STEEL

The following practice for heat-treating casehardened carbon steel was recommended and adopted at the Atlantic City meeting of the American Society for Testing Materials, and referred to the members for letter ballot.

1. When hardness of case only is desired and lack of toughness or even brittleness is unimportant, the carburized objects may be quenched from the carburizing temperature, as for instance, by emptying the contents of the boxes into cold water or oil. Both the core and the case are then coarsely crystalline.

2. In order to reduce the hardening stresses and to decrease the danger of distortion and cracking in the quenching bath, the objects may be removed from the box and allowed to cool before quenching to a temperature slightly exceeding the critical range of the case, namely, 800 to 825 degrees C. Both the core and case remain coarsely crystalline.

3. To refine the case and increase its toughness, the carburized objects should be allowed to cool slowly in the carburizing box within the furnace or outside to 650 degrees C., or below, and should then be reheated to a temperature slightly exceeding the lower critical point of the case (in the majority of instances a temperature varying in accordance with the carbon content and thickness of the case between 775 and 825 degrees C., will be suitable), and quenched in water, or, for greater toughness but less hardness, in oil. The objects should be removed from the quenching bath before their temperature has fallen below 100 degrees C. This treatment is more especially to be recommended when the carburizing temperature has not exceeded 900 degrees C. It refines the case but not the core.

4. To refine both the core and the case and to increase their toughness, the objects should be allowed to cool slowly from the carburizing temperature to 650 degrees C. or below and should then be (*a*) reheated to a temperature exceeding the critical point of the core, which will generally be from 900 to 950 degrees C., followed by quenching in water or in oil; and (*b*) before they have cooled below 100 degrees C., they should be reheated to a temperature slightly exceeding

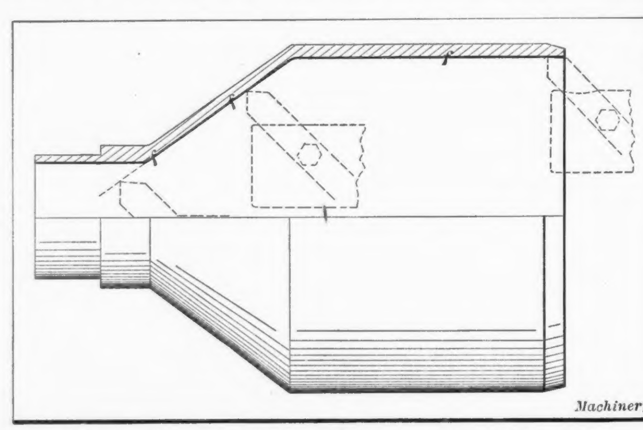


Fig. 3. Steel Bowl showing Section covered by Boring Tool. Production 20 to 34 Finished Bowls in Ten Hours

the lower critical point of the cast (in the majority of instances a temperature varying in accordance with the carbon content and thickness of the case between 775 and 825 degrees C. will be suitable), and again quenched in water or oil.

The objects should be removed from the quenching bath before they have cooled below 100 degrees C., in order to lessen the danger of cracking, and they should be placed in the reheating furnace while still at a temperature of at least 100 degrees C., likewise to lessen the danger of cracking, it being inadvisable (*a*) to allow steel to cool completely in the quenching bath and (*b*) to place hardened steel in a hot furnace. Obviously, if the furnace is cold the hardened steel may likewise be cold when placed in it for reheating.

5. In order to reduce the hardening stresses created by quenching, the objects, as a final treatment, may be tempered by re-heating them to a temperature not exceeding 200 degrees C.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

VAN NORMAN AUTOMATIC RADIAL GRINDER

The Van Norman Machine Tool Co., Waltham Ave., Springfield, Mass., is now building a No. 3½ automatic radial grinder for grinding raceways in cups, cones, or end-thrust rings for ball bearings. After the machine has been properly

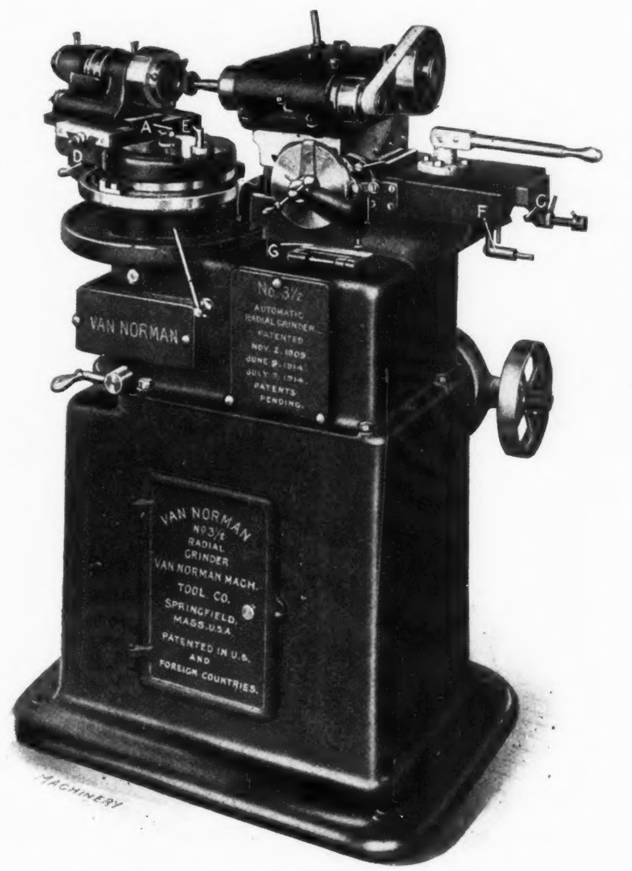


Fig. 1. Van Norman No. 3½ Automatic Radial Grinder for grinding Single-row Ball Bearings

adjusted and the work set up in the work holder, the wheel is brought in cutting contact with the raceway, after which the operation is entirely automatic. Two important advantages are obtained in this way: first, one operator is able to look after a group of machines, so that the production cost is materially reduced; second, the precision of the machine rather than the skill of the operator is responsible for the accuracy of the work, so that it is possible to employ less highly trained help for grinding the raceways of the highest grades of ball bearings. This, of course, means a further reduction of production costs. Where a considerable amount of stock is to be removed, it has been found desirable to rough- and finish-grind in two operations. One machine or group of machines is arranged for the roughing cut, using a coarse wheel and operating with a fast feed. The finishing cut is done with a fine wheel and slower feed. These machines are built in two styles. Fig. 1 illustrates the machine for grinding single-row ball-bearing races, while the machine for grinding double-row races is shown in Fig. 2. The general design of these machines is the same and the description applies to both except that a detailed description is given of the means for shifting the work-head in grinding double-row bearings on the machine shown in Fig. 2.

The most obvious features of these machines are their compact and rigid construction, and the provision of handy appliances which facilitate setting up the work and operating the machine. The extreme nicety which is required in the making of high-grade ball bearings to insure accuracy and interchangeability of parts is so well known that it requires no comment. This high degree of accuracy makes it necessary for grinders used in finishing ball bearing parts to be so constructed that there is practically no vibration. Particular attention has been paid to this point in designing these new Van Norman grinders. Referring to the illustrations, it will be seen that the slides upon which the work-head and wheel-head are mounted are located directly over the main frame of the machine. The slides are of unusually massive construction, which, together with the way in which they are supported, reduces vibration to a minimum. The work which different manufacturers grind on these machines varies considerably in shape and size. For this reason no standard style of work-holding equipment is sent out with the machines. The work-holding head oscillates about a vertical pivotal center, in order to obtain the required curvature of the race, and the necessary depth is obtained by the cross-feed of the wheel-head.

In preparing one of these machines for operation, there are three settings to be made: First, the work-head must be positioned by adjusting the upper head slide so that a line through the center of the path of the raceway to be ground will be exactly over the vertical pivotal center. Second, the work-head is positioned by means of the cross-slide of the head so that the radial center of the raceway is exactly over the vertical pivotal center. Third, the grinding wheel must be brought to the correct grinding position over the pivotal center. These settings of the work-head and grinding wheel are accomplished by means of a series of stops used in conjunction with plugs or distance gages of the required lengths which are placed between the stops. This will be better understood by the following description, which explains the method of procedure for each case.

Fig. 2. Van Norman No. 3½ Automatic Radial Grinder for grinding Double-row Ball Bearings

As a typical example of making the transverse setting, suppose it is required to grind a race in which the diameter of the ball center circle is 1.5 inch. It will be necessary to locate the head 0.750 inch off center, and this is done by means of a plug or gage, the length of which is exactly 0.750 inch. When in contact, the stops shown at *A* in Figs. 1 and 2 locate the central axial line of the work-holding spindle exactly over the vertical pivotal center of the oscillating head, while the stops shown at *B* in Fig. 3 locate the shoulder on the spindle exactly over the pivotal center when these stops are in contact. The 0.750-inch plug or gage is placed between the stops shown at *A* in Figs. 1 and 2, and the slide brought up so that both stops engage the ends of the plug. The cross-slide of the work-head is then locked in this position. The next step is to move the work-head back the required distance so that the radial center of the race held in the work-holder is exactly over the axis about which the head swings. For this purpose the shoulder near the front end of the spindle is made the reference point, and this shoulder is exactly over the axis about which the work-head swings when the stops *B* are in contact. Suppose that a work-holding fixture of the form shown in Fig. 4 is used, in which the distance from the reference point on the spindle to the face of the work-holding fixture against which the race is held is 1.250 inch. Further, assume that the race is 0.750 inch wide. Under these conditions it will obviously be necessary to have the reference point on the spindle 1.625 inch from the axis about which the work-head oscillates. This is done by means of a second plug or gage 1.625 inch in length placed between the stops *B* on the longitudinal slide of the work-head, which is shown in Fig. 3.

The next step is to locate the grinding wheel over the center line of the work, as indicated at the left-hand side of Fig. 4. The wheel-head is mounted on a slide which is moved back and forth by means of a hand-operated rack and pinion. When the wheel is in the working position, the adjustable stop shown at *C* in Figs. 1 and 2 is in contact with its bearing on the frame of the machine. In order to true the wheel, the work-head is moved around to its central position, where a plunger *D* enters a hole in the swivel slide support and holds the truing device securely in place. In this position the post *E* upon which the diamond holder is mounted is properly located. The distance between the axis about which the work-head oscillates and the center of the stud upon which the truing device is mounted is approximately 3 inches. In order to true the wheel, it is obviously necessary to move it back to the diamond point, and this is accomplished by means of the distance plug shown at *F* in Figs. 1 and 2, the length of this plug corresponding to the distance between the vertical pivotal center and the center of the stud *E*. In starting to true the wheel, the wheel-slide is released and moved back rather more than 3 inches; after which the 3-inch distance plug is swung into place and the slide moved forward to bring the stop *C* into contact with it. This locates the wheel in the correct position for truing.

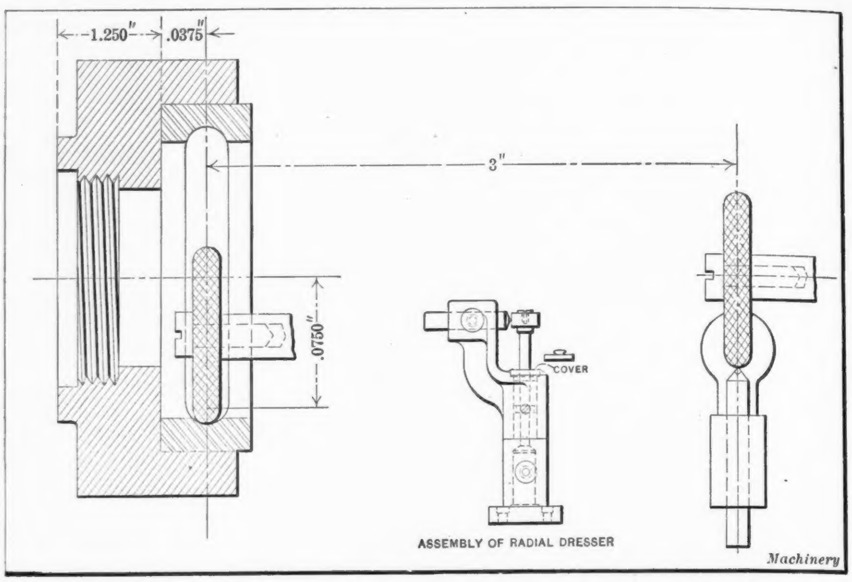


Fig. 4. Diagram showing Method of setting up the Work and truing the Wheel


Fig. 3. Rear View of the Van Norman No. 3½ Automatic Radial Grinder

With this preliminary statement, the method of procedure in setting up a new wheel in correct relation to the work may be explained. With the stop *C* in contact with the distance plug *F*, the wheel is brought into contact with the diamond point, which may be swung back and forth about its stud. The first step is to locate the wheel in such a position that the diamond point is centrally located in regard to the wheel. If it is found that the wheel is not located centrally on the diamond point, the adjustable stop *C* is regulated until the wheel is brought into the required position. This also locates the wheel in the correct relation to the work, because when the wheel has been trued, the distance plug *F* is removed and the wheel-slide brought forward to bring the stop *C* up against its bearing on the frame of the machine, causing the slide to be advanced exactly 3 inches. This brings the wheel central in regard to the work. After the wheel has been used for such a length of time that it requires truing, it is merely necessary to move the wheel-slide back and engage the stop *C* with the distance plug *F*, as previously described, and then swing the diamond point back and forth across the periphery of the wheel.

Fig. 4 also shows a detailed view of the device for truing the wheel. The stud upon which the wheel-truing device is mounted is secured to the base of the oscillating head; and the method by which the wheel truing device is located in line with the spindle of the wheel-head has already been described. Referring to the assembly view shown in Fig. 4, it will be seen that the bracket in which the diamond holder is mounted is slipped over the stud and held in place by a binding screw. It is obviously necessary to have the diamond holder located in different positions in the bracket when tru-

ing wheels for grinding races of different radii. This is conveniently accomplished by having a small disk, the diameter of which is the same as the radius of the raceway to be ground, set up on a pin which slips into a hole in the bracket, as shown in the illustration. With the proper sized disk in place, the diamond point is brought into contact with the disk, after which the binding screw is tightened to secure the diamond holder in place. With this device any operator is competent to adjust the diamond point for truing the wheel to the correct radius, provided he has been given a disk of the proper diameter. The bracket and diamond holder which it carries are swung back and forth on the stud to true the wheel.

The wheel-head is arranged for both automatic and hand cross-feed. Power for the automatic feed is provided by the lower pulley shown at the right-hand side of the machine in Figs. 1 and 2, the power being transmitted through gearing to a vertical shaft inside the column of the machine, which is shown at *H* in Fig. 5. At the top of this shaft there is an edge cam *I*, on the upper side of which the face cam *J* is located. Each revolution of the shaft *H* brings the face cam *J* into contact with the plunger *K*, causing this plunger to be raised. The motion is transmitted by the plate *G* to the plunger *L* which actuates the pawl *M*, this pawl being adjustably set to pick the required number of teeth on the feed ratchet wheel. Each tooth of the ratchet wheel gives a cross-feed of 0.000025 inch to the wheel-head. The ratchet wheel is provided with a shoe which may be set to disengage the automatic feed at any point. When the pawl has moved the ratchet wheel around to the limit of the required motion, the shoe comes under the pawl, disengaging the feed. When so desired, the pawl *M* may be swung back out of engagement with the ratchet wheel and the small lever *N* used to feed the wheel-head by hand. Pushing down this lever causes the ratchet wheel to be turned by the second pawl shown in the illustration. Manufacturers using this grinding machine have found that the amount of wear developed in the grinding wheel in grinding each race can be accurately determined. For instance, one manufacturer has found that for the wheels and stock which he uses, the wheel is worn 0.00025 inch for each race. This wear is easily compensated for by setting the shoe on the feed ratchet after grinding each race, so that the wheel-head is fed in the necessary additional distance to compensate for the wear of the wheel.

Power for oscillating the work-head is also taken from the shaft *H*. The edge cam *I* mounted at the top of this shaft engages with a roller carried by the lever *O*. As the cam *I* rotates, the lever *O* moves to the left and transmits motion through the connecting-rod *P*. This rod is secured to the double disk *Q* which is loosely mounted on a pivot that rotates the work-head. It will be seen that the disk *Q* is made in two parts, which are secured together by two bolts, the heads of which fit in T-slots in the lower disk. By loosening these bolts, the two sections of the disk *Q* may be adjusted in relation to each other in order to regulate the field of oscillation of the work-head. The angle through which the work-head oscillates may also be adjusted by regulating the position of the crankpin which secures the connecting-rod *P* to the lever *O*. Below the double disk *Q* there is a block splined to the pivot that rotates the work-head. This block carries a tapered pin which enters a hole in the disk *Q* when it is desired to have the work-head oscillated by power.

When it is required to have the work-head free so that it may be oscillated by hand, the lever *S* is swung over to the left. This draws the tapered plunger down out of the disk *Q*, leaving the disk free to oscillate about the pivot without causing the work-head to move. The head may then be swung back and forth by hand. When it is again desired to

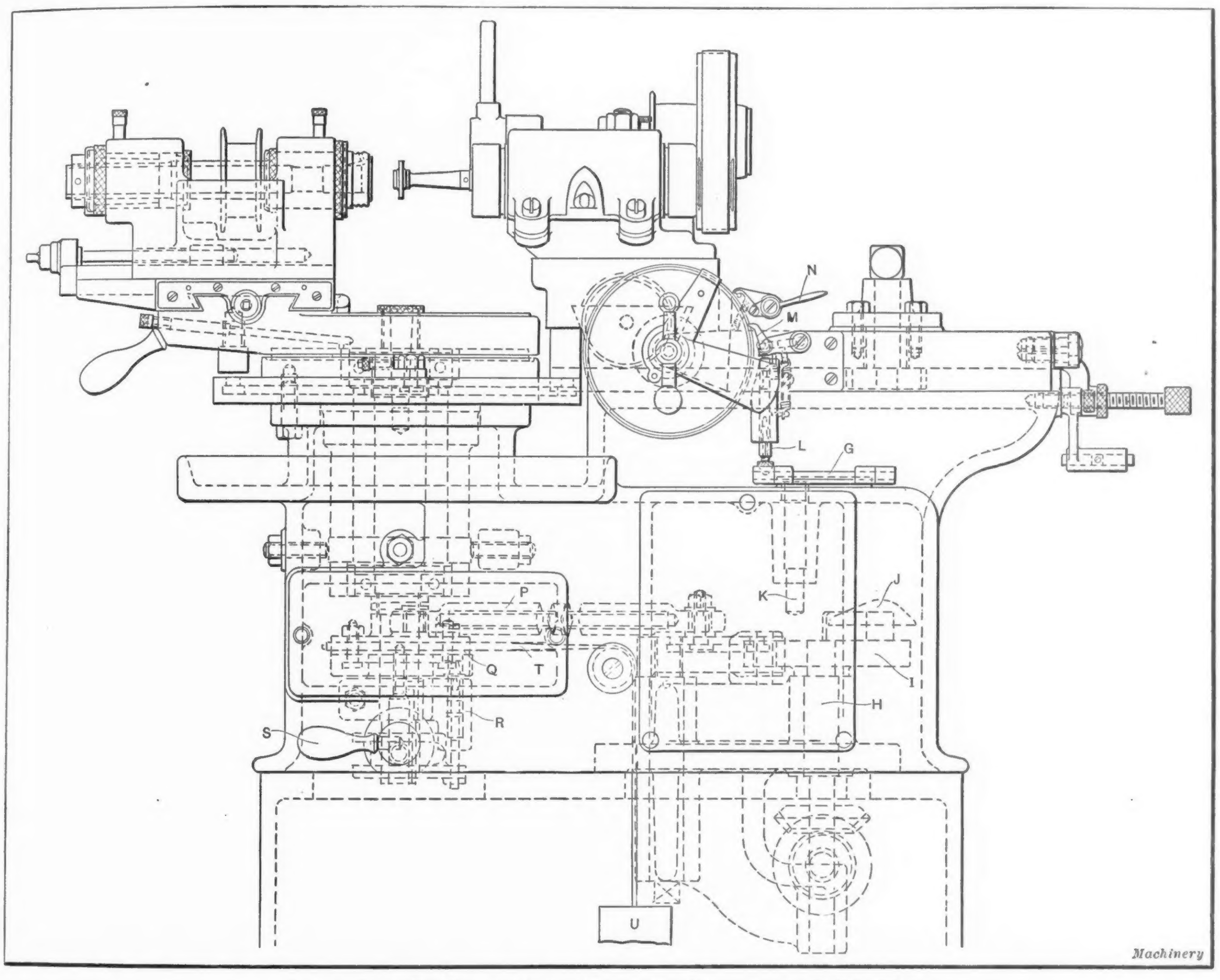


Fig. 5. Front Elevation of the Van Norman No. 3½ Automatic Radial Grinder

bring the power oscillation into action, the handle *S* is moved to the right. This releases the plunger which is pushed up against the bottom of the disk *Q* by a compression spring, and when the hole in this disk comes over the plunger, the latter is pushed up, thus connecting the disk with the pivot and bringing the power oscillation into action. The forward oscillation of the work-head is controlled by the cam *I*, as previously described, and when the high point of this cam has been passed, the work-head is returned through the action of the chain *T* and counterweight *U*, the movement being controlled by the contour of the cam. A very smooth motion is secured in this way, as the cam and roller which govern the oscillation of the head are always held in contact with each other and there is no lost motion.

Fig. 1 shows the machine for grinding the races of single-row ball bearings, while a machine for grinding the races of double-row bearings is illustrated in Fig. 2. These two machines are identical except that the one shown in Fig. 2 is provided with means for shifting the work after the first race has been ground, to bring it into position for grinding the second race. Referring to the illustration, it will be seen that there are two straight levers at the extreme left. In shifting the work, the operator swings the first of these levers over with his right hand. The lever turns a pinion which meshes with a rack on the cross-slide in the work-head, and by turning the handle the work is moved back away from the wheel. He then takes the second lever in his left hand and swings it over. This lever turns a second pinion meshing with a rack which actuates a longitudinal slide in the work-head. This slide causes the work to be moved over to bring it into the proper position for grinding the second race. An adjustable stop is provided on the longitudinal slide which can be set to enable the work-head to be brought into position for grinding the second race. The first lever is then swung back to return the work-head into position to start grinding.

Machines of this type are built either with or without a pump and water equipment for wet grinding. The regular equipment does not include chucking devices, as the great variety of work handled by different manufacturers makes it desirable for each to make his own work-holding fixtures. The radial diamond holder for truing the wheel is part of the regular equipment but the diamond is not supplied with the holder. The work-holding head swings 9 inches, and although this machine is especially adapted for grinding raceways from the smallest diameters up to 4 inches, larger sizes can easily be ground. The vital features of these grinders are protected by patents issued and pending. The net weight of the machine is 1600 pounds.

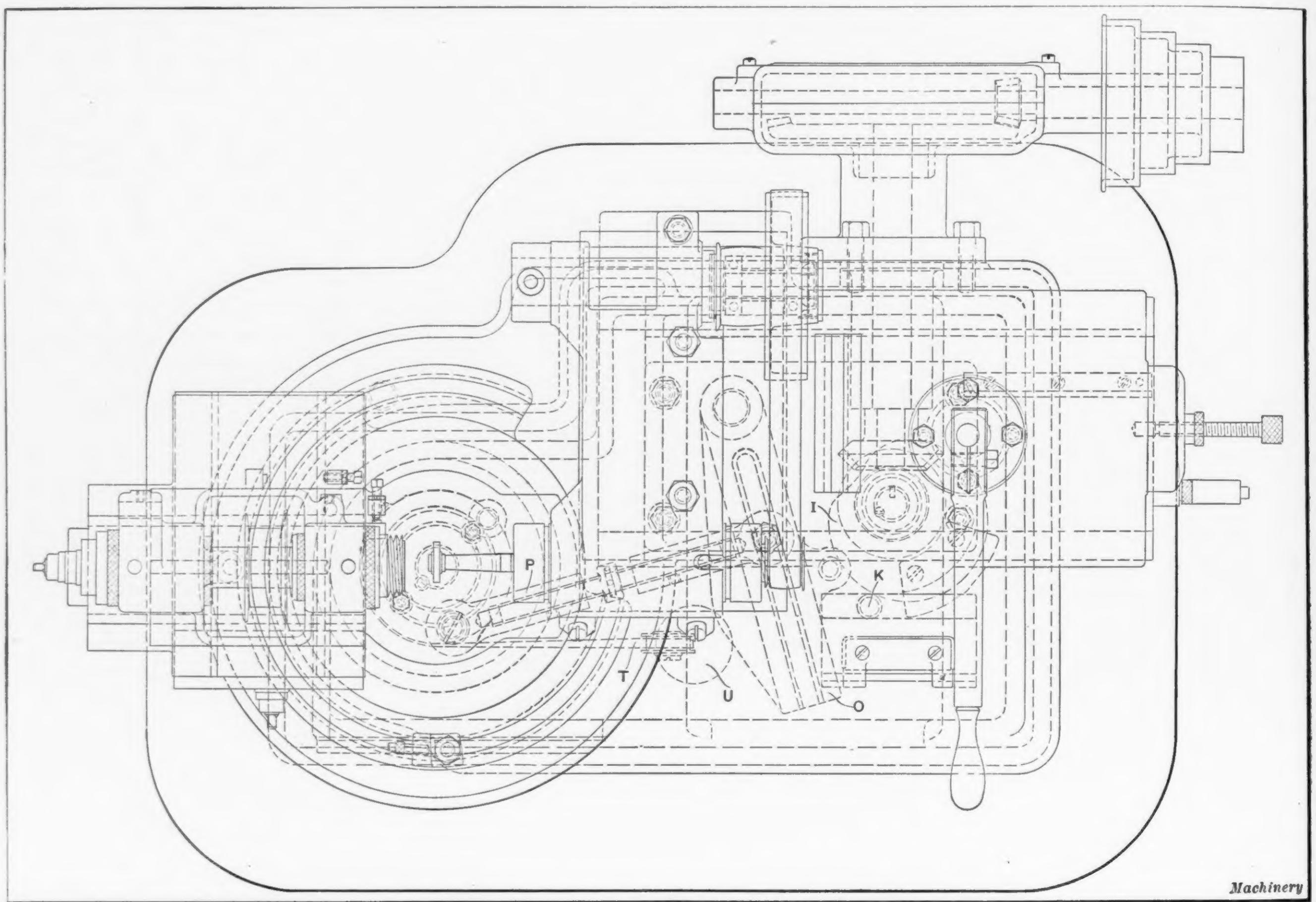


Fig. 6. Plan View of the Van Norman No. 3½ Radial Grinder

"UNIDRAFT" DRAFTING FABRIC

The Universal Drafting Machine Co., Cleveland, Ohio, is about to place a new drafting fabric upon the market which provides for making drawings and blueprints by an entirely new process. This fabric is somewhat similar to ordinary tracing cloth but it is covered with an opaque surface. In making a drawing on this material, the draftsman works with a pointed steel tool instead of a pencil; this tool is used exactly as a pencil would be and scrapes away the opaque surface along the lines which make up the drawing. This exposes the transparent fabric to permit the passage of light. In making blueprints from such drawings, the method of procedure is exactly the same as where ordinary tracings are used, but as the lines are transparent and the remainder of the drawing opaque, it will be evident that the resulting blueprint has blue lines on a white background instead of white lines on a blue background.

The use of this material eliminates the necessity of making a tracing either for the purpose of producing blueprints or for providing a clear and durable drawing for future reference. The lines are clean cut and drawings may be made on this material just as rapidly as it is possible to make them on paper with an ordinary drawing pencil. The surface of the "Unidraft" fabric is a dull brown which reflects very little light into the draftsman's eyes, thus reducing eye-strain and troubles resulting from this cause. The elimination of the necessity of making tracings is the means of effecting a considerable saving on each drawing, and where there are a great many drawings to be made on a single job, there is also a great reduction of the time required to get out

a complete set of drawings. Another advantage is that all errors due to tracing are eliminated and the checking and correcting of drawings is materially simplified, because the lines stand out far more distinctly than the lines of an ordinary pencil drawing.

It will be evident from the preceding description that it is possible to make a blueprint at any time before the drawing is completed and this is often a very valuable feature in the case of drawings showing general layouts. As the surface of "Unidraft" is a dull brown, it does not show dirt, which is another point that will be appreciated by those who have had experience in the making of drawings which are worked on for a considerable length of time, or with drawings which are allowed to lie about in places where there is a lot of dust and dirt. Another point in favor of "Unidraft" is that the necessity for sharpening pencils is eliminated because the draftsman works with a steel tool which does not change its shape.

It has already been mentioned that "Unidraft" fabric is covered with an opaque brown surface which is cut through by a steel pointed instrument. This exposes a white line which stands out in strong contrast to the dark background. An idea of how strongly the drawing stands out will be gathered from the illustrations which show reproductions of several drawings made on this material. Fig. 1 shows quite a complex structural drawing, while Fig. 2 illustrates a relatively simple design. It must be clearly understood that this material is applicable for use in making the most complicated mechanical and structural drawings and for all other classes of drawings which can be made with pencil and then traced. It is just as easy to erase a mistake made on "Unidraft" as it is to erase a line from a pencil drawing, and considerably easier than it is to erase an ink line. The erasing is done with an ordinary writing pen which inks in the line that it is desired to erase—erasing on "Unidraft" is merely a matter of replacing the opaque surface where it has been taken off by mistake. Either straight or curved lines can be erased in this way and after the erasure has been made, it is possible to redraw any part of the line with the steel tool. In the event of it being desired to change a full line into a dotted line, this is very easily done by simply dotting in the spaces with ink.

It has already been stated that the blueprints of these drawings have blue lines on a white background, but where so desired, the blueprints may be reversed. The width of the line may be varied by varying the pressure on the point

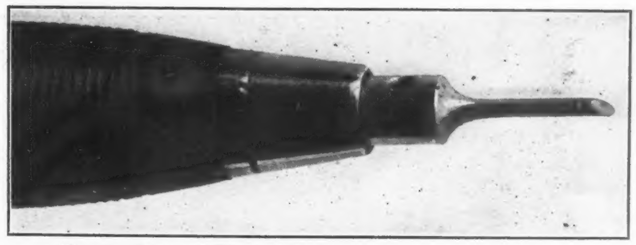


Fig. 3. Enlarged View of Tool used to draw on "Unidraft"

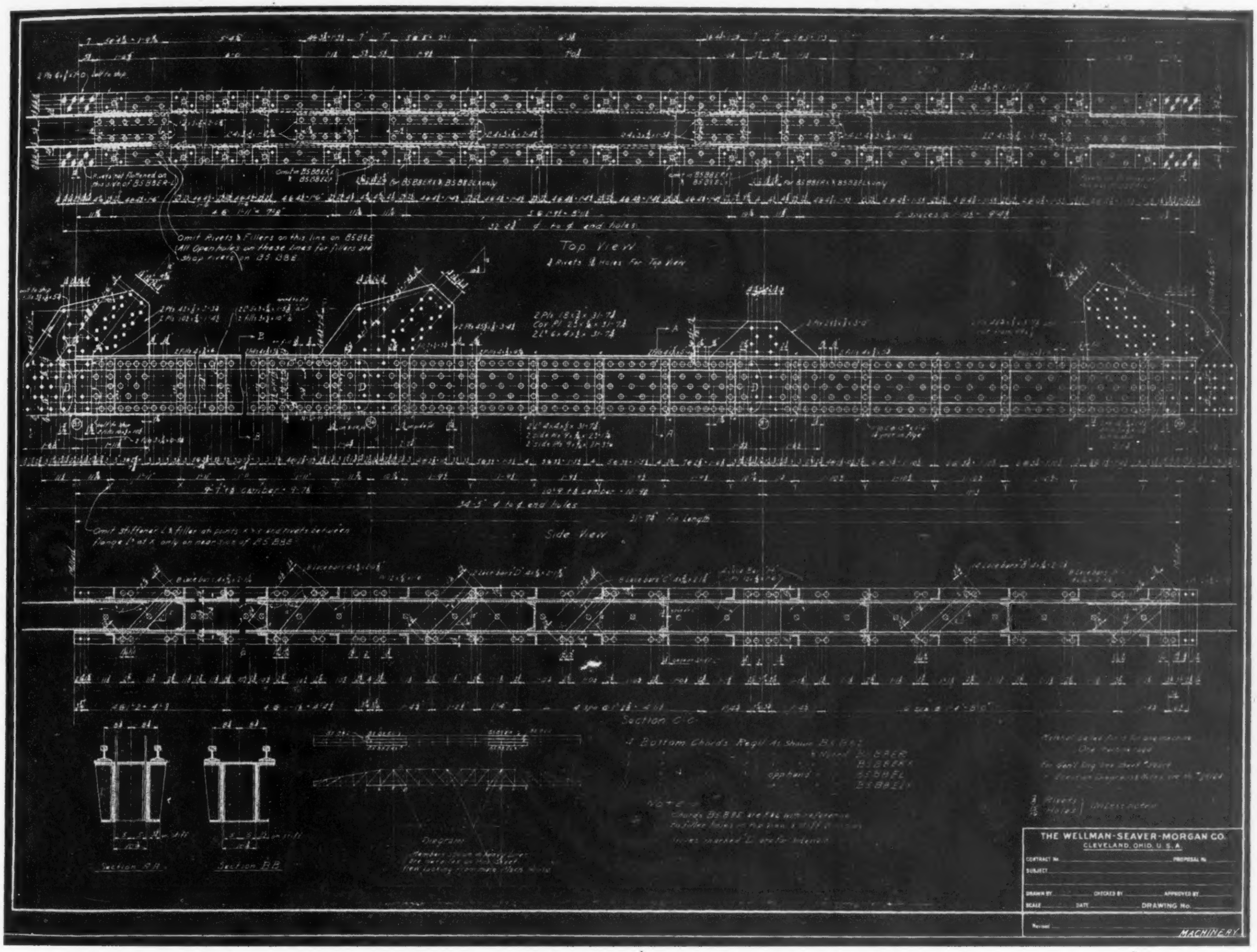


Fig. 1. Example of a Complicated Structural Drawing made on "Unidraft"

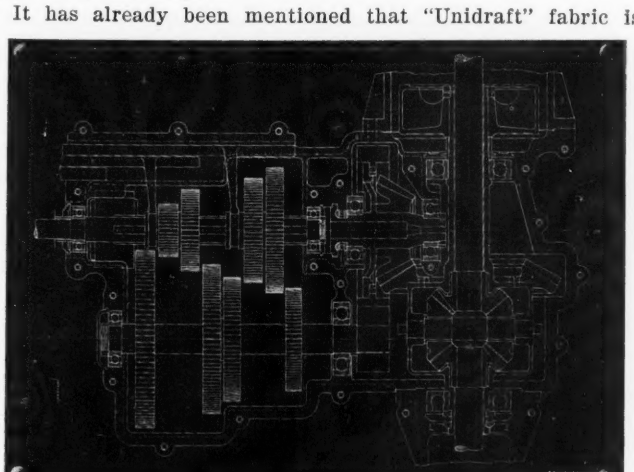


Fig. 2. Simpler Drawing—Note how the Lines stand out

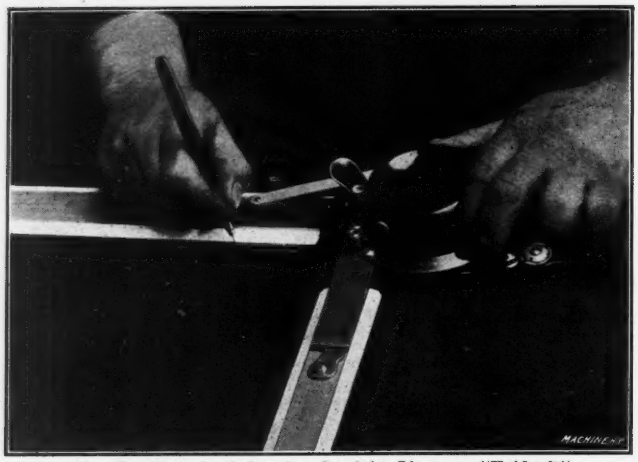


Fig. 4. Method of drawing Straight Lines on "Unidraft"

of the tool in the same way that the width of a pencil line can be varied by varying the pressure. The fabric may be worked on with a drafting machine and with the usual drafting instruments without scratching its surface except at those points where it is desired to draw the lines. Blueprints of drawings on "Unidraft" are made at about the same speed as blueprints of ordinary tracings.

Fig. 5. How Free-hand Lettering is done

It is stated that it is easier to learn to draw on "Unidraft" fabric than to learn to make a good tracing. The cost of making drawings is reduced because the original drawing can be used to make blueprints without requiring a tracing to be made. This saves the cost of tracing cloth, pencils and ink, and also the expense of a tracer's time. The elimination of errors produced in tracing is an important feature, and as the drawing stands out exceptionally clear on the dark background, it is easier to check than it is to check a pencil drawing which often becomes somewhat indistinct before it is completed.

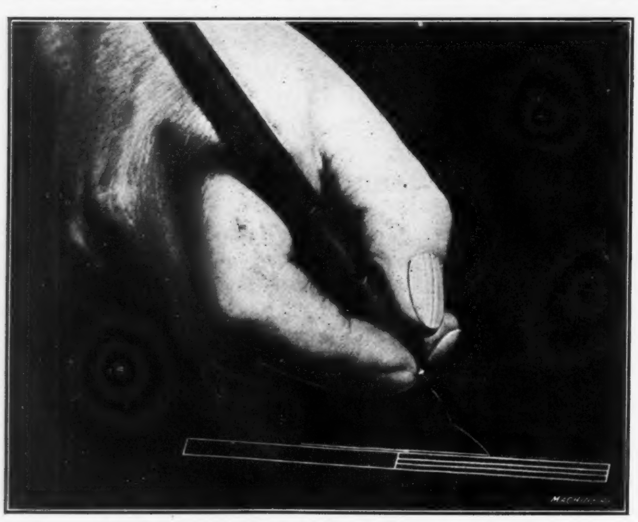


Fig. 6. The Use of an Ordinary Pen to erase a Line

Figs. 1 and 2 show reproductions of drawings made on "Unidraft," and these illustrations give a good idea of the clearness with which the lines stand out. Fig. 3 is an enlarged view of the instrument used for drawing the lines. It will be seen that the point of this instrument is rounded and fine limit lines for lettering may be made by using the tool

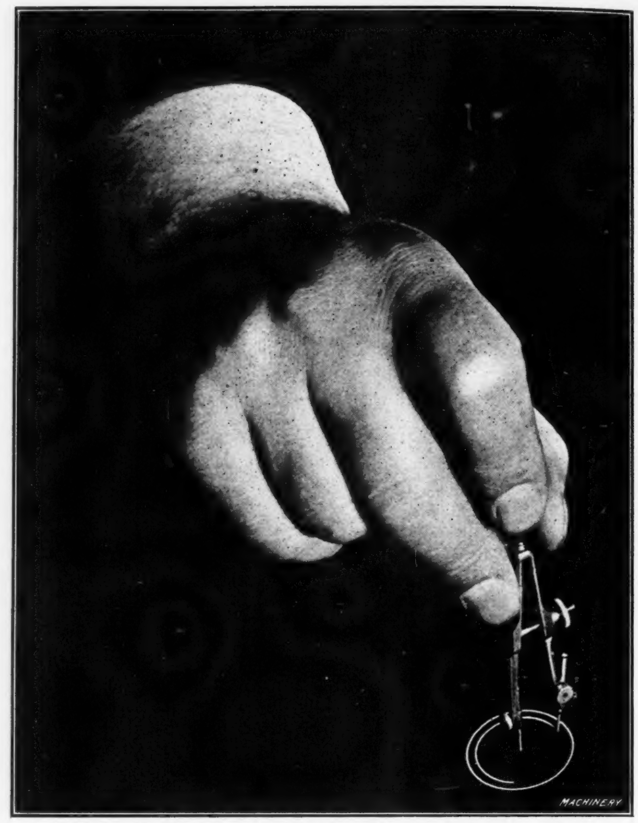


Fig. 7. A Bow-pencil provided with a Steel Drawing Point

edgewise. Fig. 4 shows the method of procedure in drawing straight lines and emphasizes the point that the lines come up clearly and distinctly as they are drawn. In Fig. 5, free-hand lettering on "Unidraft" is being done and Fig. 7 shows the use of a bow-pencil provided with a steel point for drawing circles and arcs on this material. In Fig. 6 the drafts-

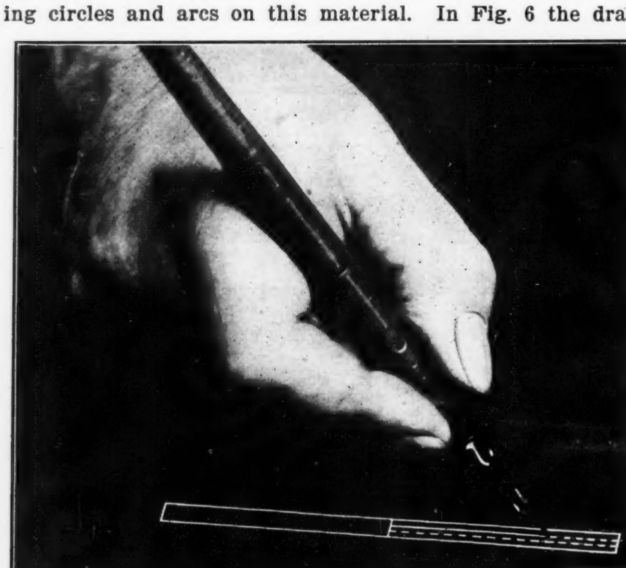
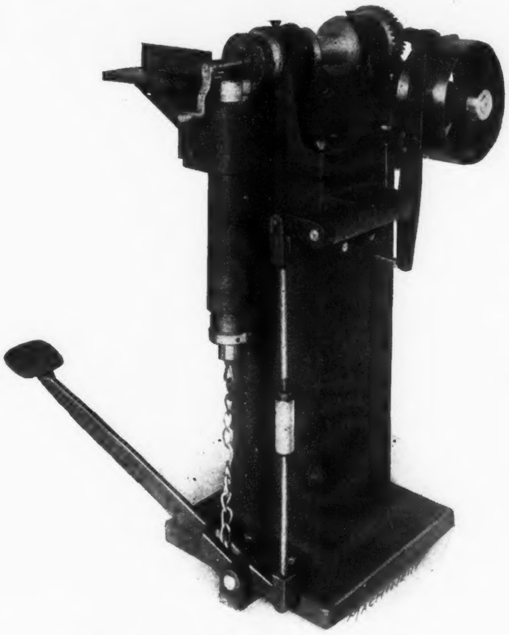


Fig. 8. A Full Line is easily converted into a Dotted Line

man is using an ordinary pen and ink to erase a line and it will be seen that the portion of the line already erased is to the right of the pen-point. Fig. 8 shows how a full line is easily converted into a dotted line by simply inking in intermediate spaces.

GARVIN COPPER COIL FORMING MACHINE

The machine shown in this illustration was designed to coil copper field coils for automobile lighting systems, taking the copper in strips and coiling it together with a strip of insulation on a rectangular arbor. The copper strip is not only cut to length, but has a right-angle bend at one end, which is used for dogging purposes. A powerful spring keeps the work against the arbor and is controlled by a foot treadle. The machine trips automatically on the completion of three revolutions of the spindle. The coils are stripped off the arbor by turning the crank handle shown in the



Garvin Copper Coil Forming Machine

center of the spindle. The next strip is put in place and the machine will start immediately on removing the foot from the treadle. Other metals can be used in place of copper, and the number of coils and their shape can be changed to suit the work. The machine is manufactured by the Garvin Machine Co., Spring and Varick Sts., New York City, and weighs 665 pounds.

CRESCENT WOOD SURFACER

To meet the requirements of shops that have work which is too heavy for the 24-inch Crescent planer, the Crescent Machine Co., 56 Main St., Leetonia, Ohio, has recently placed on the market a 26-inch machine, two views of which are shown in Figs. 1 and 2. The design is heavy and compact, requiring little floor space, but providing a capacity for handling lumber of large dimensions. There are four feed rolls, all of which are driven by flanged pulleys on each end of the machine. The feed is of the Crescent variable friction

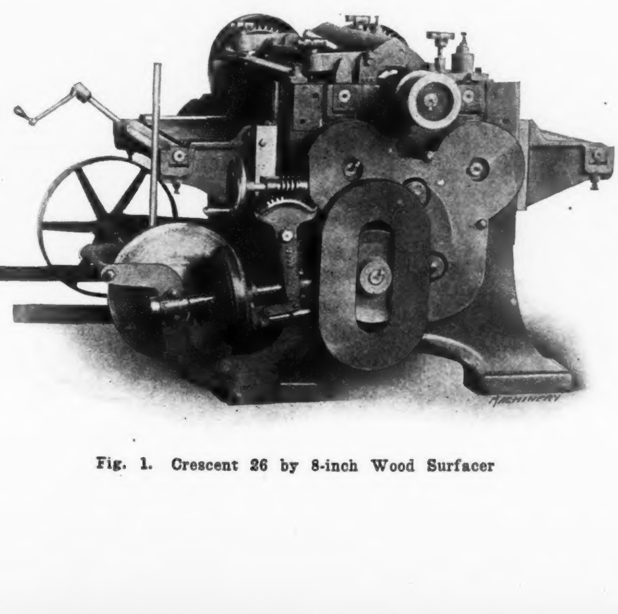


Fig. 1. Crescent 26 by 8-inch Wood Surfacer

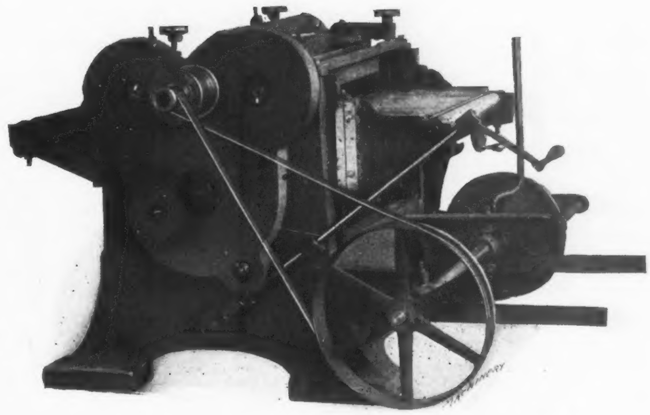


Fig. 2. Opposite Side of Crescent Surfacer shown in Fig. 1

type which has found successful application on other styles of planers built by this company. The range of feed is from 15 to 60 feet per minute, and a pointer and scale are provided for setting the machine for the proper feed.

The pressure of the upper feed rolls is obtained by springs, which some shops have found to be undesirable owing to the fact that the springs are not easily adjusted for different pressures, and because a foot treadle cannot be used to provide additional pressure when it is necessary. These difficulties have been overcome by providing a small handwheel at the top of the machine which may be turned until the desired amount of pressure is obtained. The pressure is quickly adjusted in this way and any pressure up to 600 pounds may be readily obtained. Additional pressure may be secured by operating either of a pair of foot levers. The springs which control the pressure of the rolls are flexible, and they act quickly and uniformly so that the machine is not subjected to uneven strains. The head is usually furnished with two knives, but a four-sided head may be obtained on special order. The countershaft for driving the machine is ordinarily mounted on the ceiling or it may be set on the floor back of the machine where such an arrangement is found more convenient.

"LITTLE DAVID" RIVET SET RETAINER

To provide for the safety of the operators of the "Little David" riveter of its manufacture, the Ingersoll-Rand Co., 11 Broadway, New York City, has recently provided a rivet set retainer for use on this tool. This attachment consists of but a single piece of heavy spring steel, closely wound into a spiral form. One end of this spring fits over the outside of

"Little David" Riveter equipped with an Improved Rivet Set Retainer

the hammer nozzle and hooks over a projection integral with the nozzle. The other end is wound to a smaller diameter. Sets for rivets over 7/8 inch diameter are formed with a coarse thread and are simply screwed into place. Sets for rivets 7/8 inch diameter and smaller are formed with a shoulder and are slipped into the retainer while it is detached from the hammer, the shoulder holding it in place. The device positively prevents the rivet set or piston from being driven out, even when the hammer is run free.

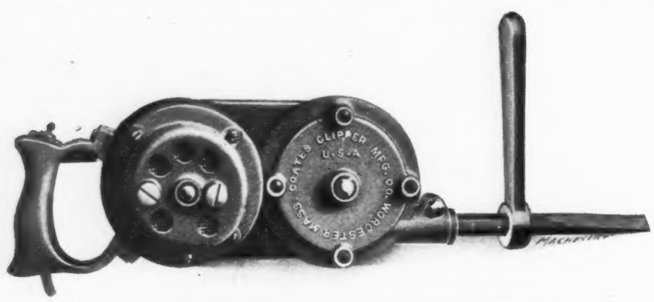
Other important improvements have been embodied in the "Little David" riveter. There is but a single ground joint between handle and barrel, and these parts are securely held together by two bolts, one on each side of the barrel. This construction eliminates the need of a vise in taking the tool apart for inspection, a feature of value to the structural worker, as well as to others who are not usually equipped with

special facilities for repair work. There are no threaded joints on the barrel. The valve chamber is placed beside and parallel to, instead of in line with the cylinder, obviating any possibility of injury to the valve by the piston. This construction gives a very much shorter tool, adding to its usefulness, as it can be used in closer quarters.

"Little David" riveters are made with either outside or inside types of triggers, in five regular sizes adapted for all kinds of riveting work. In addition, there are two sizes of jam riveters which have an exceptionally short over-all length, making them peculiarly well adapted for riveting in very cramped quarters.

COATES CENTRIFUGAL CHIPPING HAMMER

One of the recent products of the Coates Clipper Mfg. Co., Worcester, Mass., is an electrically driven centrifugal chipping hammer. This tool has found successful application in chipping castings, cleaning the bottoms of ships while in dry-dock, making bolt holes in concrete and a variety of similar classes of work. Power is supplied by a 1/5 horsepower electric motor which is connected to the centrifugal hammer by spur gears. There is a spur gear on the armature spindle and



Coates electrically driven Centrifugal Chipping Hammer

a spur gear on the spindle of the centrifugal hammer, these gears being connected by an intermediate gear. The "ducking" or centrifugal hammer consists of a disk which has the hammers pivoted at its periphery. The disk rotates at high speed, and centrifugal force causes the hammers to fly out and strike the end of the chipping tool, after which they "duck" back to permit the disk to continue its rotation. The hammer delivers two thousand blows per minute on the chipping tool.

STANDARD ROLL GRINDING MACHINE

The Standard Engineering Co., Ellwood City, Pa., is now building a roll grinding machine equipped with two heads, both of which are located on the same side of the roll and arranged for grinding both the necks and bodies. The whole machine is of very massive construction so that a large amount of work can be produced without sacrificing quality. The roll is carried on dead centers and driven by a 10 horsepower variable speed motor mounted on the headstock. The motion is transmitted to the roll by two sets of worm gears entirely enclosed in an oil-tight case, and provided with ball thrust bearings. The headstock is fixed at one end of the machine while the tailstock is movable longitudinally by means of a rack and pinion. In addition to the longitudinal movement, the tailstock has also a transverse adjustment for lining up and grinding tapers. Each of the grinding heads is provided with a 26-inch wheel driven by a 15 horsepower motor mounted on the grinding wheel carriage. This motor is of the variable speed type in order that the peripheral speed of the wheel may be kept uniform as the diameter is reduced through wear. Each wheel is protected by a heavy steel guard, that can be easily removed when changing wheels.

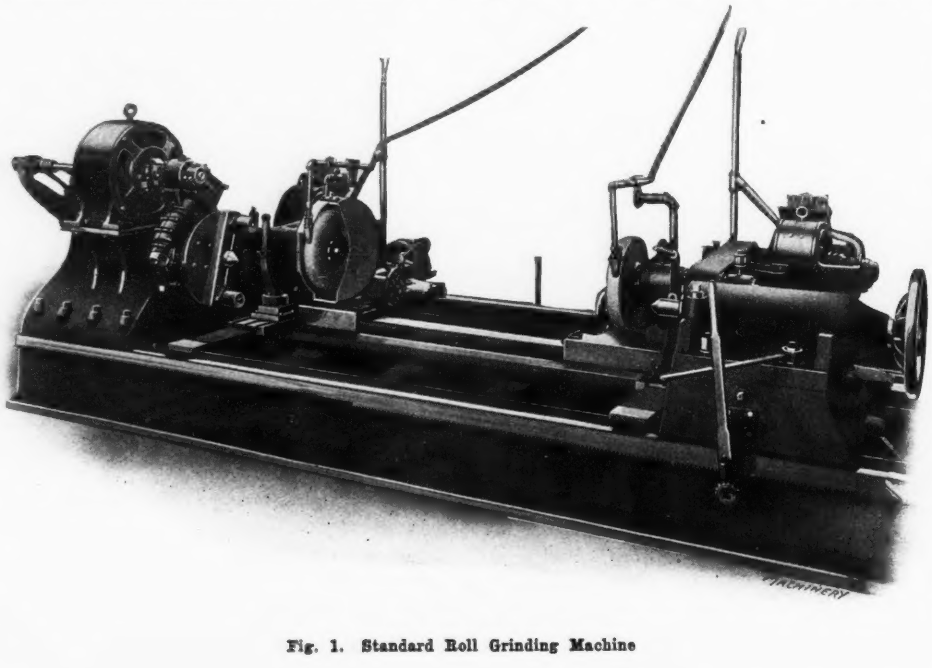


Fig. 1. Standard Roll Grinding Machine

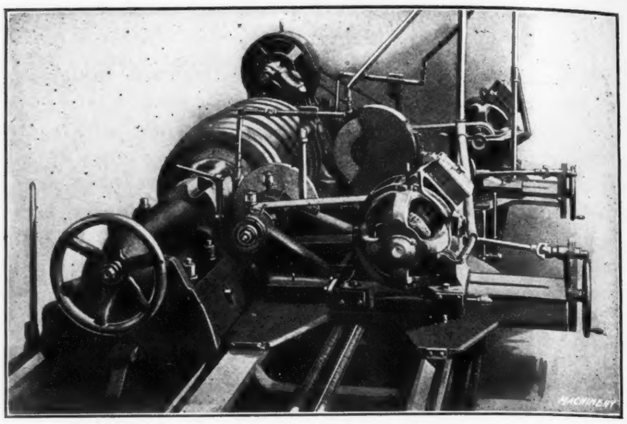


Fig. 2. Partial Plan View of Standard Roll Grinder

The longitudinal travel of each head is obtained by a screw driven by gearing and a belt from the headstock motor. This gearing has clutches for controlling the motion of the grinding head, operated by a handle which may be set at any convenient position on the front of the bed. In addition to the handle, the clutches may be operated by a stop on the carriage so as to obtain a continuous motion in both directions. This motion of the carriage may also be obtained by means of a handwheel which revolves the screw when the clutches are disconnected. The transverse travel of each grinding head is accomplished by means of a screw having a handwheel mounted on its end. In addition, another handwheel is provided which is geared to the screw for the adjustments. This last handwheel and the one for operating the carriage longitudinally are placed in positions which are convenient for the operator while watching his work. The machine is provided with devices for truing the grinding wheels, so arranged that the wheels may have their edges rounded to suit fillets in the roll necks. In addition to carrying the roll on centers, the machine is provided with housings for carrying the roll by its necks in case this method is desired when grinding bodies. These housings are adjustable so that rolls may be "crossed" or various kinds of tapered work accomplished. The machine swings 50 inches and when provided with a bed 30 feet in length, which is the size required to accommodate rolls having a length of 21 feet, it has a weight of about 80,000 pounds.

MONARCH GEARED HEAD LATHES

To meet the demand for a lathe equipped with individual motor drive or single pulley drive, the Monarch Machine Co., Sidney, Ohio, has added to its line the 16-inch by 6-foot and the 14-inch by 6-foot machines which are illustrated in Figs. 1 and 2. Fig. 1 shows the application of motor drive, and Fig. 2 shows a machine equipped with the single pulley for taking power direct from the line-shaft. It must be understood, however, that either machine may be provided with single pulley drive or motor drive according to the requirements of the shop in which it is to be installed. The geared headstock provides eight mechanical changes of spindle speed, any of which may be instantly obtained by operating two levers at the front of the headstock. With the driving shaft running at 300 revolutions per minute, spindle speeds of 25, 40, 58, 83, 116, 182, 262 and 375 revolutions per minute are obtainable. This is a wide enough range for most classes of work, but for exceptional cases a two-speed countershaft or a variable-speed motor may be employed to extend the range.

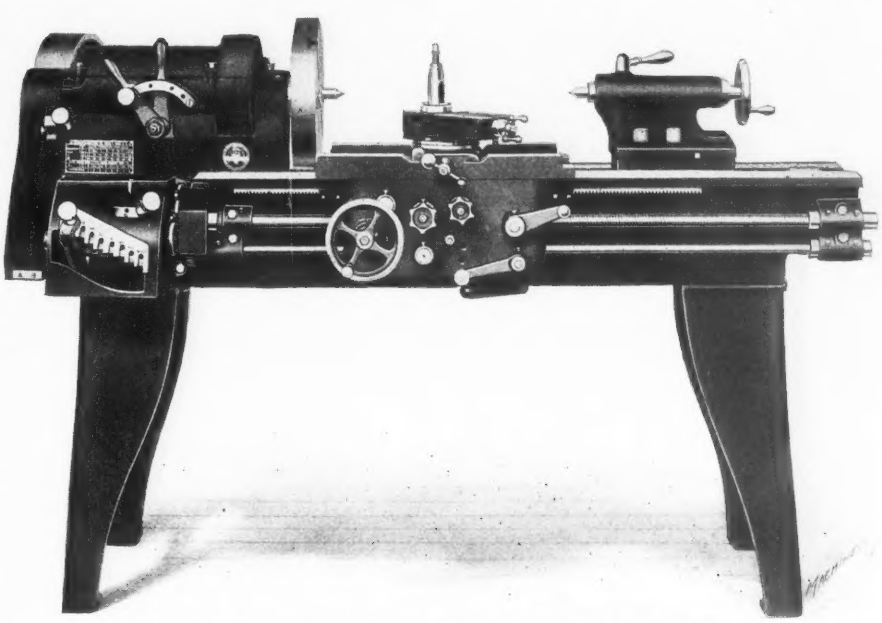


Fig. 2. Monarch 14-inch Lathe equipped with Single Pulley Drive

The geared headstock applied on these lathes is the automobile sliding gear type of transmission with positive clutches. There are twelve gears, eight of which are constantly in mesh. All of the gears have cut teeth; they are 8 pitch and $1\frac{1}{4}$ or $1\frac{1}{2}$ inch face width. All bearings are bushed with phosphor-bronze and the changes are obtained by two levers operating over segments on the front of the headstock. The gears run in oil and the bearings are thoroughly lubricated by the splash system. The headstock is oil-tight and a drain is provided so that the oil may be run out for cleaning. Provision is made for instantly stopping the spindle and then starting it again at the same speed. This is a particularly useful feature when it is required to stop the work for measuring.

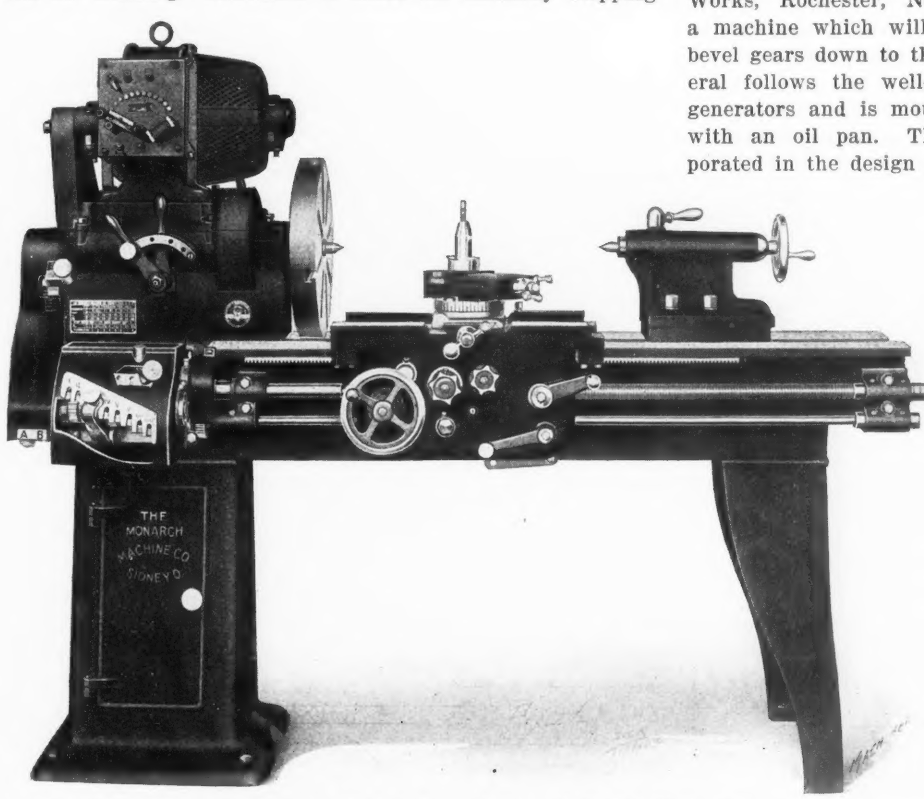


Fig. 1. Monarch 16-inch Lathe equipped with Electric Motor Drive

For machines equipped with single pulley drive, the pulley is provided with a friction clutch which is operated by a shipper rod at the back of the lathe. Where individual motor drive is employed, a $1\frac{1}{2}$ or 2 horsepower motor is used. The motor should run at from 1000 to 1400 revolutions per minute. Where the motor is mounted on the headstock, the drive is through a silent chain, which is completely enclosed to provide for the safety of the operator. An ordinary starter such as a manufacturer would recommend for use with a constant-speed motor can be used. This starter is usually mounted as shown in Fig. 1.

GLEASON THREE-INCH BEVEL GEAR GENERATOR

The accompanying illustrations, Figs. 1 and 2, show a small size, generating bevel gear planer developed by the Gleason Works, Rochester, New York, to meet the demand for a machine which will accurately and rapidly handle small bevel gears down to the finest pitches. The machine in general follows the well-known lines of the Gleason two-tool generators and is mounted on a pedestal which is integral with an oil pan. There are several new features incorporated in the design which facilitate rapid changing of the work. Shifting the head is accomplished by means of a rack and pinion operated by a lever, and a micrometer stop is supplied for readily setting the head to any desired distance from the cone center of the machine. The distance from the apex of a gear to the back of the hub being known, to set the head in position all that is necessary is to set the micrometer stop to this distance and then bring the head up to the stop. The locking of the head is effected by means of a single locking lever.

The use of the tool gages is also simplified by supplying a limit gage 0.0005 inch over and under for length, with a separate gage for the pressure angle. The machine can be arranged for either belt or individual motor drive, and Fig. 2 shows the method of attaching the motor. This generator will handle any bevel gear not over $2\frac{1}{8}$ inches cone distance and $\frac{3}{4}$ inch face. The largest pitch recommended is 8 diametral pitch and the smallest pitch for which tools are made as standard is 32 diametral pitch. Smaller pitches can be cut, but this is limited by the tool, which must be of sufficient thickness at the point to stand up to the cut.

Fig. 1. The New Gleason 3-inch Bevel Gear Generator

The machine will generate a tooth in four seconds as the fastest, and forty seconds as the slowest speed. The extremes of tool speed are 400 strokes per minute and 120 per minute, and a slip gear arrangement is provided for throwing the tools out of gear while making changes. The indexing mechanism is positive and runs in an oil bath; and the feed mechanism is similarly provided for. All the wearing surfaces on the machine are square gibbed and the shaft bearings are bronze lined. All gears are pack-hardened, and an oil pump is part of the regular equipment. The machine weighs 1250 pounds and takes 44 by 32 inches floor space.

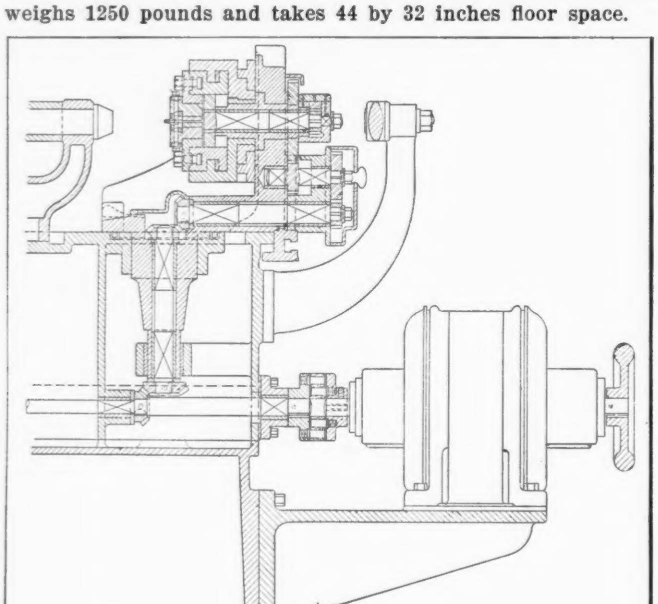
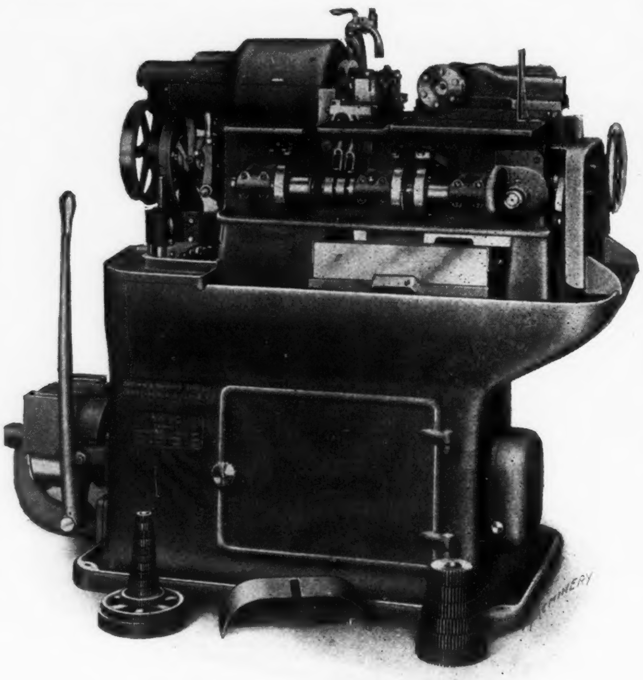


Fig. 2. Partial Cross-sectional View showing Application of Electric Motor Drive

BROWN & SHARPE NO. OG AUTOMATIC SCREW MACHINE

A recent addition to the line of automatic screw machines manufactured by the Brown & Sharpe Mfg. Co., Providence, R. I., is shown in the accompanying illustration. A notable feature of this machine is the method of driving it, only one belt being used. The main driving pulley runs in one direction at a constant speed and is equipped with a friction clutch for starting and stopping, allowing the machine to be belted directly to the lineshaft, with all overhead works eliminated. Not only does this permit the belt-driven machines to be placed to much better advantage on the shop floor, but it makes the arrangement for individual motor drive comparatively simple. A constant-speed motor is employed, it being attached to the rear of the cabinet base. The main driving shaft runs through the base of the machine. Power is transmitted from this shaft to the spindle by a pair of belts, one for driving forward and one backward, an automatically operated friction clutch controlling the change.



Brown & Sharpe No. OG Automatic Screw Machine

Speed changes are made by means of a pair of change gears located outside of the base at the right-hand end, under the hinged cover. An automatic speed change is incorporated in the driving mechanism and operated by the machine feed shaft. This serves to slow down the spindle in the ratio of 1 to 2¼ for threading and similar operations. This machine handles bar stock up to ½ inch in diameter and turns work to 1¾ inch in length. It is known as the No. OG automatic screw machine. The details of construction and operation of the driving mechanism on this machine are similar in general to those on the No. OOG automatic screw machine, which was fully illustrated and described in the April, 1913, number of MACHINERY.

"CAPITAL" GRINDER

A small rapid production internal grinder has recently been placed on the market by the Lansing Stamping & Tool Co., Lansing, Mich. This machine is rigidly built and is an accurate and economical producer. The grinding spindle is rigidly mounted and driven by two belts, which overcomes vibration or any tendency for the spindle to run out of truth. The machine is designed to finish holes from ⅝ inch to 2 inches in diameter and up to 2 inches in length. Power feed for the table is not provided, because it has been found that for a short hole more satisfactory results are obtained by using hand feed. The feed is accomplished by means of a handwheel which operates a rack and pinion. The table is of heavy construction and the ways are automatically oiled

with rolls set in the bed; this gives a particularly smooth action and makes it possible to produce work with a very high finish. Chatter marks are also entirely eliminated by this construction.

One of the principal features of this machine is the means provided for stopping the work chuck in order to gage the hole. This is accomplished by the mechanism shown in Fig. 2 which consists of a roll carried by a bracket at the back of the table which, through a tripping device, operates a clutch on the countershaft when the table is moved to the extreme of its travel. This clutch is of the conical type and furnished with cork inserts. A spring on the countershaft throws the clutch back into engagement when it is desired to start the machine. The clutch is operated by a fork at the end of a bellcrank lever which receives its motion from a tie-rod operated by a tripping dog. This dog is engaged by the roll carried on a bracket fastened to the table of the machine. As the table is thrown back out of the operating position, this roll comes into contact with the tripping dog, throws the clutch out of engagement and operates the brake, thus stopping the rotation of the work instantly. The clutch can also be thrown out by a foot lever shown in Fig. 2. The provision of this means for stopping work is of such importance that one automobile manufacturer who is using these machines for certain grinding operations has found it possible to increase his rate of production 50 per cent. Also, many parts which were formerly finished by lapping are now ground on this machine.

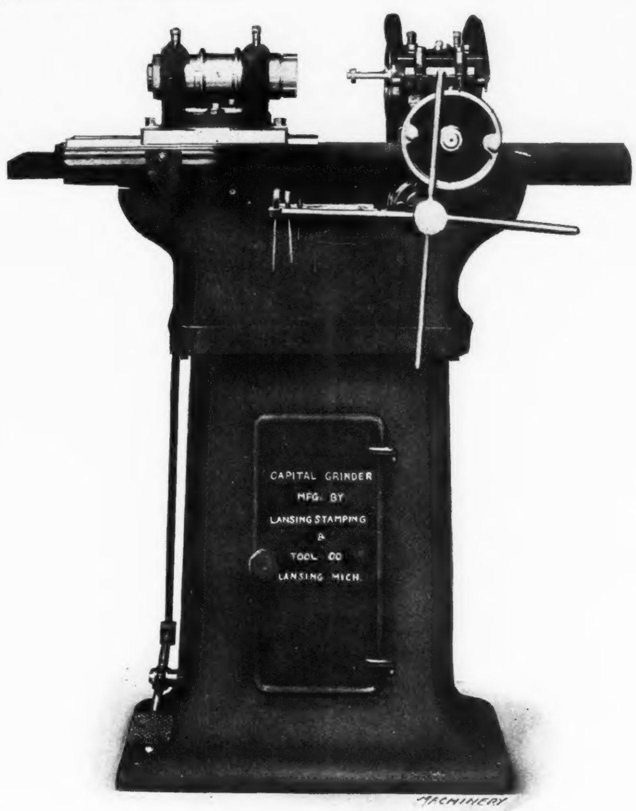


Fig. 1. "Capital" Internal Grinder

Fig. 3 shows a cross-sectional view of the headstock which is very rigid in design and provided with phosphor-bronze tapered bearings that enable adjustment to be made to compensate for wear. The spindle is fitted for carrying spring chucks but jaw chucks can also be used. The spindle is made from 50 point carbon crucible steel; it has a 1¼-inch hole through its center to provide for handling collet work and is large enough to accommodate a dust collecting pipe used in connection with the machine when dry grinding operations are being performed. The table upon which the headstock is mounted is made of cast iron; it is 36 inches long with wide V and flat ways and has oiling rollers set in the bed.

The internal grinding spindle is made of hardened and ground tool steel and runs in Hess-Bright ball bearings

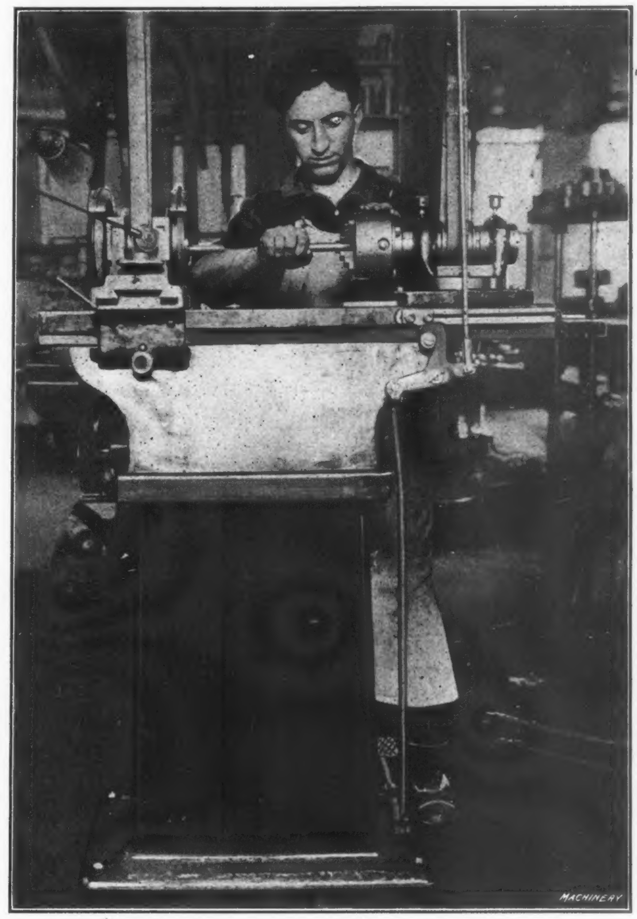


Fig. 2. Rear View of "Capital" Internal Grinder, showing how the Work Chuck is stopped automatically

which have a four-point bearing at the front and a three-point bearing at the rear. This spindle is provided with felt washers to prevent dust getting into the bearings and is capable of running at a speed of 22,000 revolutions per minute. It is driven by two belts which not only afford a steady drive but also eliminate any binding of the spindle in its bearing. This tends to equalize the belt pull and insures a true running spindle. The grinding head is set by a handwheel and dial which has two hundred graduations and can be set to 0.001 inch.

The following will give an idea of the productive capacity of this machine. On cams for automobile cam-shafts the holes in which are ⅞ inch in diameter by ⅞ inch long, and from which 0.008 inch has to be removed from the inside diameter, a production of 60 cams per hour is secured. The cams are heat-treated steel. Another job handled on this machine consists of grinding a hole ¾ inch in diameter by 1¾ inch long in spindle bushings, and this work is produced at the rate of sixty pieces per hour, the same amount of metal being removed from this hole as in the preceding case.

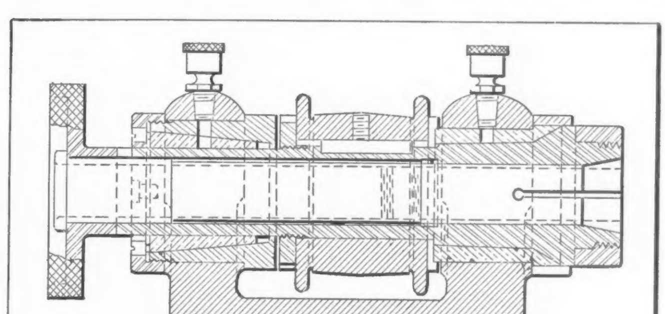


Fig. 3. Cross-sectional View of Headstock of "Capital" Internal Grinder

Bushings for roller bearings which are 1¼ inch in diameter by 2 inches long, and which are required to have an extremely high finish and to be perfectly accurate as regards the concentricity of the bore from end to end, are finished on this machine in a very satisfactory way.

As previously mentioned, the feature of this machine which makes possible such high rates of production is the fact that the work chuck can be instantly stopped for gaging the work. The machine has only one belt shifter which is operated by moving the table back. The workman can caliper the work very rapidly, and in addition to allowing him to turn out work more quickly, the machine is also capable of the highest possible accuracy. The following gives the principal dimensions of these grinders: traverse of table, 10 inches; greatest distance from wheel spindle to work spindle,

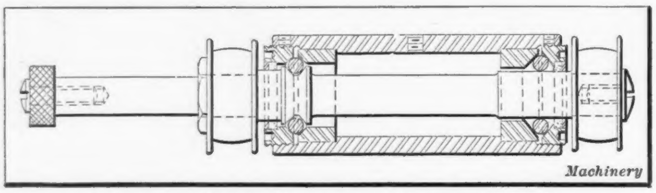


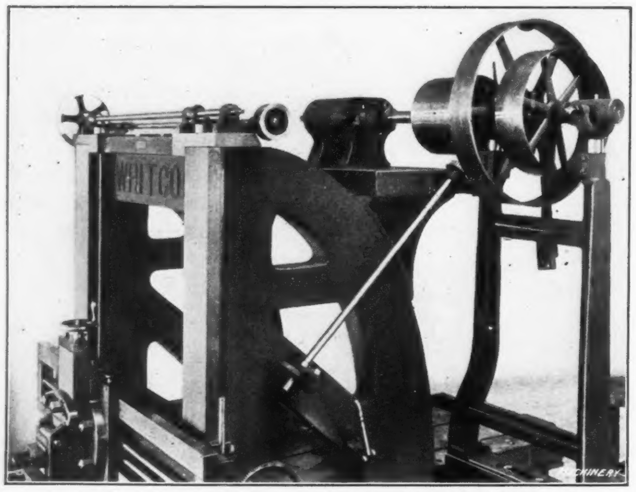
Fig. 4. Special Head for Use in grinding Valve Seats

12 inches; swing of work-head over table, 8 inches; swivel of work-head, 60 degrees; size of nose on work spindle, 2 inches in diameter with eight left-hand threads per inch; and length of cross-slide, 15 inches.

WHITCOMB-BLAISDELL PLANER WITH GEARED SPEED BOX

The accompanying illustration shows a planer recently built by the Whitcomb-Blaisdell Machine Tool Co., 134 Gold St., Worcester, Mass., which is equipped with a geared speed-box. This is nothing more than the sliding gear automobile transmission applied to a planer.

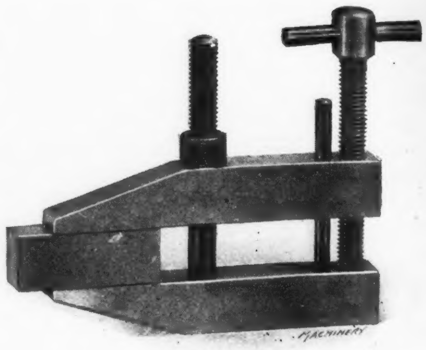
It will be seen from the illustration that the gear-box is mounted on a bracket secured to the housings of the planer. At the side of the machine there is a dial with four stations in which a spring plunger can be entered by operating a suitable hand lever. By locating the plunger in any of these holes, the corresponding pair of gears in the change gear box are engaged to give the required forward speed. The forward speed shaft telescopes inside the return speed shaft. Four cutting speeds of 25, 35, 45 and 60 feet per minute are available, and the return speed is constant at 100 feet. The illustration shows the machine equipped for belt drive, but it is a very easy matter to mount a motor on the bracket and provide the necessary gearing for individual motor drive.



Sliding Gear Speed Box for Whitcomb-Blaisdell Planer

M. B. HILL CLAMP

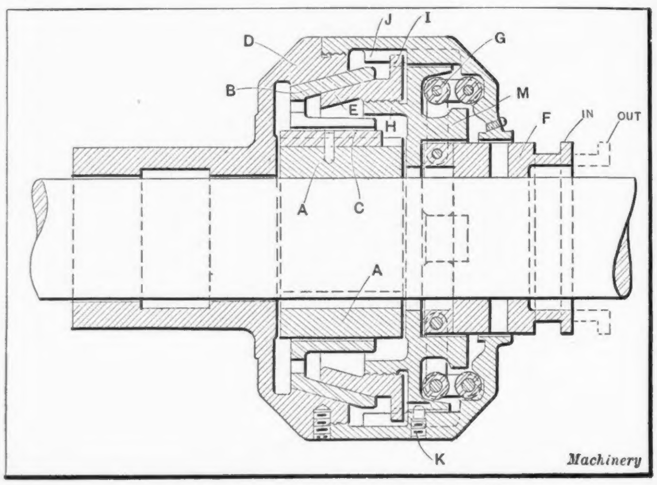
The accompanying illustration shows a clamp made by the M. B. Hill Mfg. Co., Worcester, Mass., which is so designed that one side is prevented from dropping down by means of a pin placed in front of the rear screw. This clamp can be operated with one hand, leaving the other hand free to handle the work. It is claimed that the work can be held more securely and with less strain on the screws than is possible with the old style of clamp, as the pin causes the jaws to have a more even contact on the work. These clamps are made in three sizes to meet the requirements of different classes of work.



M. B. Hill Clamp

AKRON MULTI-CONE CLUTCH

The accompanying illustration shows a cross-sectional view of the "Ideal" multi-cone clutch which is a recent product of the Akron Gear & Engineering Co., Akron, Ohio. This is what might be called a multiple-disk cone clutch and its design represents a departure from the usual types of friction clutches. In order to avoid too sudden engagement of the cones, the face angles are greater than those of the ordinary two-cone clutch, and the clutching force and pulling power lost in this way is compensated for by the addition of a third cone which practically doubles the pulling power. The cones run in oil and have oil films between them which permit the clutch to slip before the films are broken down by the contact pressure. In this way the too sudden engagement of the clutch is avoided.



Cross-sectional View of Akron Multi-cone Clutch

The design of the cones, together with the application of the oil bath, permits immediate disengagement of the clutch when it is thrown out. Very little force is required to throw in the clutch and the movement of the shifter is relatively small so that the clutch is suitable for foot control or for use in places where long levers cannot be employed. The horizontal pressure exerted by the throw-in mechanism is equally distributed over the complete surface so that there is no tendency to distort the cones. When the clutch is thrown out of engagement, the throw-in mechanism is at rest and there is no danger of centrifugal force engaging the clutch.

Referring to the illustration, the driving ring *A* is keyed to the shaft and the middle or driving cone *B* is driven from the ring *A* by means of two feather keys. Both friction surfaces of the cone *B* are provided with oil grooves. The driven cones *D* and *E* are brought into contact with the middle cone *B* when the shifter sleeve *F* is pushed in. When this lever is pushed in the rollers *G* are thrown outward and

forward against the ring H, carrying the cone E forward into contact with the middle cone B, and then carrying the middle cone into contact with the outer cone D. Having these cones come into contact singly prevents the clutch from engaging too suddenly. The inner cone E is made to revolve with the outer cone D by means of lugs I which project outward from the ends of the cone E and ride between lugs J located on the inside of the casing. The faces of these lugs J are turned true and serve to hold the ring H centrally. The casing screws onto the outer cone D and is locked in place by set-screws.

The inner end of the locking screw K enters one of the slots in the outside of the ring H, causing this ring to revolve with the casing. The adjustment of the clutch is made by inserting this screw into one of the slots. The rollers G and the pivots on which they are supported are of large diameter and bearing area to afford long life and easy operation. In throwing the clutch out the rollers G strike the lugs M and pull the cone E forward to give the required clearance for the oil films between the surfaces of the cones. The face angle of the cones is large enough to enable them to disengage instantly. The throw-in mechanism is very powerful, the multiplication between the horizontal force on the shifter sleeve F and the pressure on the cone faces being approximately 100 to 1 for all sizes of clutches.

"NATCO" HIGH-SPEED MULTIPLE DRILLS

The National Automatic Tool Co., Richmond, Ind., has recently added to its line two high-speed multiple drills which embody many features of high productive value. These meet the demand for powerful machines capable of drilling up to 7/8-inch holes in cast iron at heavy feeds. The "Natco" No. 18 drill shown in Fig. 1 is of the table feeding type, the head being tongue grooved and bolted solidly to the column. It is designed to drive eight 1/2-, twelve 3/8- or twelve

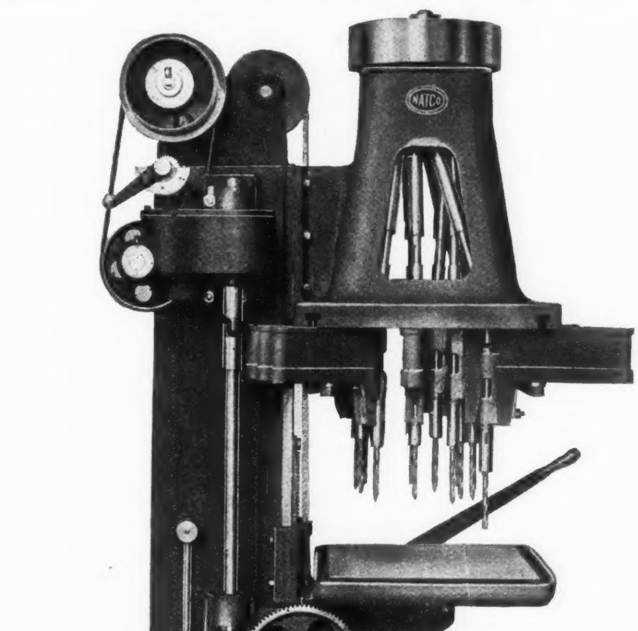


Fig. 1. No. 18 "Natco" High-speed Multiple Drill

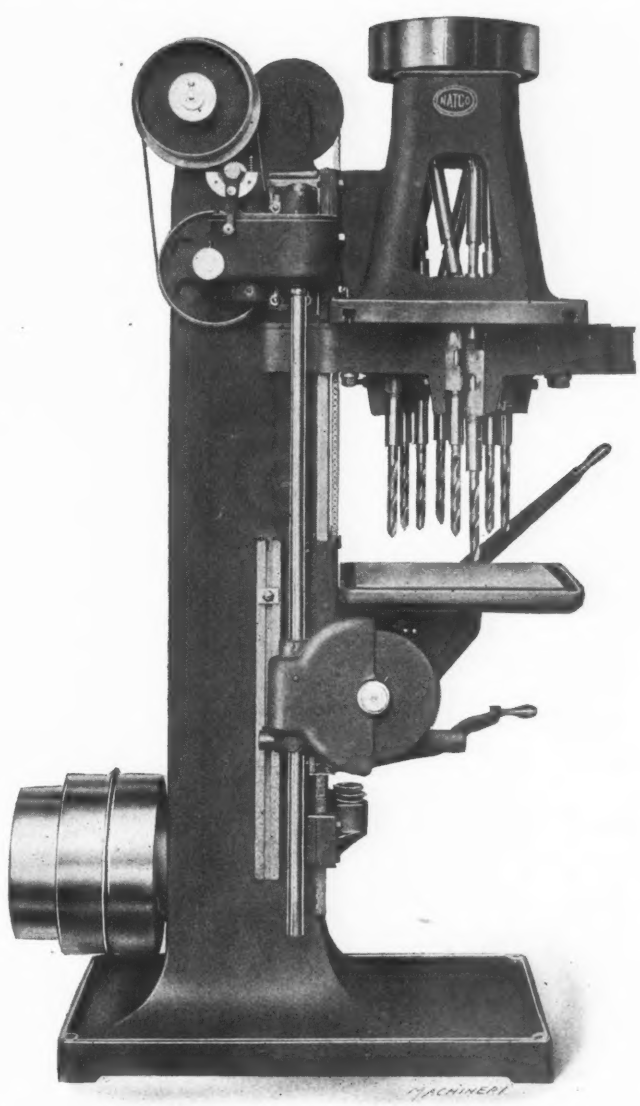


Fig. 2. No. 20 "Natco" High-speed Multiple Drill

5/16-inch drills in cast iron at a feed of 5 inches per minute with the drills running at a peripheral velocity of 75 feet per minute. Under a test it carried a much heavier complement of drills than the above with ease under the heaviest feeds. The "Natco" multiple drill embodies weight, proper distribution of metal to insure maximum rigidity, proper speeds and feeds for high-speed drills and, above all, a machine with all its parts designed to deliver the power necessary to obtain the above results.

The column is of heavy box section, the metal being so distributed as to insure a maximum of strength and rigidity. It has a wide face to which a steel rack is securely fastened. The drive is by means of a two-step cone and continuous belt. The idler pulleys are of large diameter and are mounted on Hyatt high-duty roller bearings. The cone pulley on the base is also mounted on Hyatt high-duty roller bearings. This insures a high transmission efficiency. The knee has an extended top providing a support where it is needed most and the main part is of box section which insures a very stiff support for the work to be drilled. It is counterbalanced with sectional weights which may be added to or removed to suit the work being drilled. The table is made with a large oil channel around the outer edge to catch the overflow of lubricant, and a screen oil pocket in this channel prevents chips from choking up the pipe. The feed box is located near the top of the column on the side, which provides three changes of feed that may be made while the machine is running. The feed gears are hardened and run at moderate speeds in a bath of oil. All the bearings are bronze bushed. The feed worm-gear is made of bronze, the worm being provided with an extra heavy ball thrust, and the bearings at this point are bronze bushed. A guard is provided which completely covers these parts.

The rack pinion shaft is made of crucible steel and the pinion is cut from the solid. This construction insures great strength. The right-hand end of this shaft is provided with an adjustable hand lever or a four-arm pilot for rapid, easy advance and return of the table. The power feed which is of the worm knockout construction may be tripped by hand or automatically at any point. The table returns automatically to its "home" position after being tripped. Pressing down on the feed lever releases, and pulling up engages the feed. This machine is provided with a 9 by 15-inch rectangular head which can be equipped with from two to sixteen adjustable spindles. All gears in the head are hardened and ground and run in oil. All bearings are bronze bushed. The head may be equipped with various combinations of arms or cluster boxes. The drill spindles are made of special steel hardened and ground and provided with ball thrust bearings at the lower end and lock-nuts at the upper end to take up any end wear that may develop. The spindles are made to carry either straight shank or Morse taper shank drills, as required, and the machine may be provided with a reservoir to carry lubricant to the point of the drills.

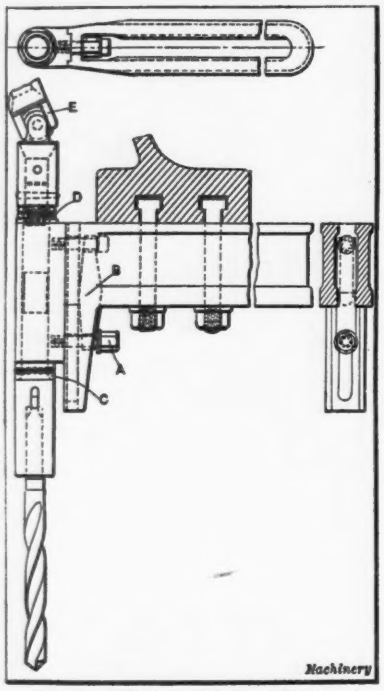


Fig. 3. "Natco" Spindle Adjustment

The bronze bearings which carry the drill spindles are provided with vertical adjustment to compensate for variation in the drill collets. This adjustment is quickly and easily secured by simply loosening one nut which is always accessible, regardless of how close the spindles may be clustered together. This spindle adjustment—which is a patented construction—holds the bearing rigidly to the end of the arm, and the arm may be moved to cover any layout within the range of the head. The construction is illustrated in Fig. 3. In making the adjustment, it is only necessary to loosen the nut *A*, as mentioned. This allows the steel beam *B* to rock on its fulcrum and loosen the bearing to provide for making the adjustment. The ball thrust bearing on this spindle is shown at *C* and the lock-nuts and washer for taking up end wear are illustrated at *D*. It will be seen that an oil chamber is provided in the bronze bearings in order to insure adequate lubrication of the spindles. The universal joints used on the "Natco" multiple spindle drills are milled from the solid and carefully hardened. One of these joints is shown at *E* in Fig. 3. This is composed of only five pieces and does not depend upon a cross-pin that may be broken, or upon screws that may work loose. The weight of this No. 18 drill is 1400 pounds without the adjustable arms.

The "Natco" No. 20 drill shown in Fig. 2 is a heavier machine equipped with larger sizes of heads and a greater number of spindles. It is an extremely powerful machine capable of driving up to 7/8 inch high-speed drills in cast iron. The table feeds the work up to the drills, the head being tongue grooved and bolted securely to the column. It was designed to drive from six to eight 3/4-inch drills or their equivalent in cast iron, at a feed of 5 inches per minute with the drills running at a peripheral velocity of 75 feet per minute. The No. 20 drill embodies all the essentials for high-speed drilling results, namely, weight, proper distribution of metal to insure rigidity, proper speeds and feeds for high-speed drills.

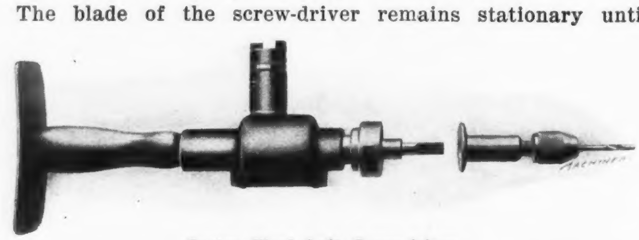
The column is of heavy box section, and has a wide face to which the steel rack is securely fastened. The drive is by means of a two-step cone and continuous belt, the two-step cone being mounted on Hyatt roller bearings. The idler pulleys are of large diameter and also mounted on Hyatt roller bearings. The knee has an extended top, providing a support where it is most needed, and the main part is of box section. It is counterbalanced and is provided with a new friction power feed which is an entirely new principle applied to multiple spindle drills. The advantage of the friction power feed is that the drills can be brought up against the work before throwing in the feed, thereby saving time in bringing the work to the point of the drills. It also eliminates any danger of breakage to the power feed mechanism, because should anything become caught, the friction would slip when the pressure reaches a certain point. The friction is adjustable to compensate for the different loads that are being drilled. The rack pinion shaft is made of crucible steel and the pinion is cut from the solid, insuring great strength. The right-hand end of this shaft is provided with either an adjustable lever or four-arm pilot for rapid, easy advance or return of table. The power feed may be tripped by hand or automatically at any point, the table returning automatically to its "home" position. The table is made with a large oil channel to catch the overflow of cutting lubricant and a screen pocket prevents chips from choking up the oil pipe.

The feed box is located on the side of the column near the top. It provides three changes of feeds. The feed gears are hardened and run at moderate speeds in a bath of oil. All the bearings are bronze bushed. Several sizes of heads are provided, all of which may be equipped with various combinations of adjustable arms or cluster boxes. Some of the heads are equipped with the "Natco" independent drill speed feature which gives two independent changes of speed in the head for each step on the cone, thereby making possible the drilling of large and small holes in the same operation at correct cutting speeds. All gears in the head are hardened and ground and run in oil. All bearings are phosphor-bronze bushed. The smaller sized heads are arranged with from two to sixteen adjustable spindles and the larger sizes have from two to twenty-four adjustable spindles. The adjustable arm, drill spindles and universal joints are of the same construction as illustrated in Fig. 3 for the description of the No. 18 drill. The main points of advantage of the No. 20 drill over the No. 18 is greater capacity, the independent drill speed feature, larger sizes of heads, greater number of spindles and the new friction power feed. The weight of the No. 20 drill is 2300 pounds without the adjustable arms.

COATES FLEXI-SHAFT SCREW-DRIVER

The power-driven screw-driver which forms the subject of this article is a recent product of the Coates Clipper Mfg. Co., Worcester, Mass. This tool is driven by one of the flexible shafts manufactured by this company, which transmits power to the screw-driver through a worm and worm-wheel. The thrust of the worm is taken by a ball bearing so that the tool runs very smoothly at all times.

The blade of the screw-driver remains stationary until



Coates Flexi-shaft Screw-driver

pressure is applied to the breast-plate. This pressure engages a friction clutch and starts the tool operating. The clutch may be adjusted so that it will release at different pressures according to the work which is being handled. This feature prevents marring the slots in the heads of the screws when they have been driven home. When the pressure on the breast-plate is released, the clutch is disengaged.

Different sizes of screw-driver blades may be mounted in the tool to adapt it for different classes of work. The tool may also be used for drilling operations. For this purpose, a drilling attachment is provided which has a slot at its

upper end into which the blade of the screw-driver fits. The arrangement will be readily understood from the illustration without requiring further description.

GREENFIELD NO. 1 PLAIN GRINDER WITH HYDRAULIC TABLE FEED

The Greenfield Machine Co., Greenfield, Mass., is now building a plain grinding machine for handling cylindrical work up to 12 inches in length and up to 4 inches in diameter. For those plants manufacturing small parts which can be finished by grinding, this machine has several features that commend it. The most noteworthy point in the design is the application of a hydraulically operated table. This method of driving does away with all gears, clutches, etc., usually employed for this purpose and it is claimed by the manufacturers that it is far superior in smoothness and evenness of operation. The machine is adapted for either straight or taper grinding and is essentially a manufacturing machine. Front, rear and plan views are shown in Figs. 1, 2 and 3; and Fig. 4 shows the way in which the hydraulic table mechanism operates.

The method by which the table operates is clearly shown

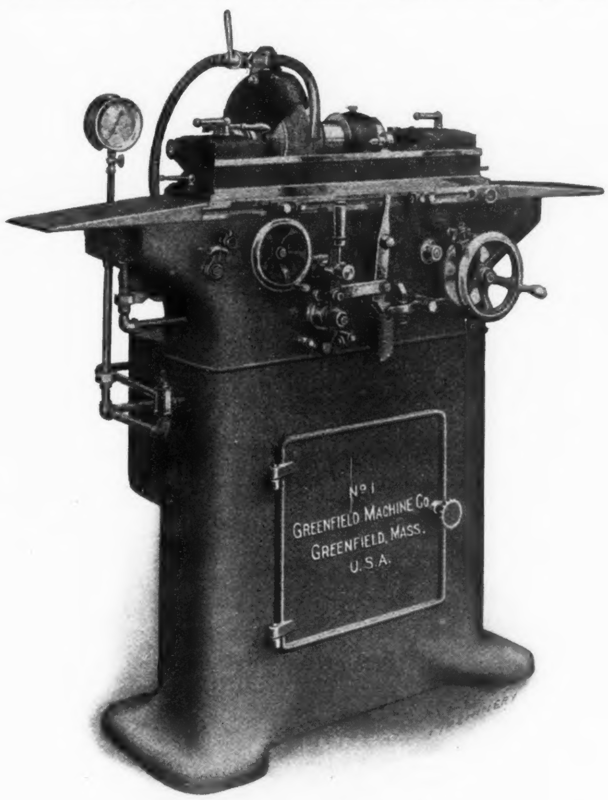


Fig. 1. Front View of Greenfield Grinder

in Fig. 4. In the base of the machine there is an oil supply tank, which supplies oil to the hydraulic cylinder. This oil is pumped by means of a rotary pump which will be seen at the rear of the machine in Fig. 2. Referring to this illustration it will be seen that the oil piping extends around the left-hand end of the machine to the relief valve. This valve is usually set to give about 75 pounds pressure which is indicated on the gage directly above. The oil held back under pressure by the relief valve goes to the operating valve, which is illustrated in Fig. 4. In one position the oil passes to the left of the piston within the cylinder, which is shown in Fig. 3, forcing the piston toward the right until the operating valve is shifted—either by hand or automatically—when it reverses by causing the oil to flow into the cylinder from the opposite end and thus moves the piston and table, to which it is attached, in the other direction. The speed with which the table is traversed is governed by a supply valve which controls the amount of oil passing to the cylinder, and any desired speed between 0 and 254 feet per minute may be obtained with a pressure of 75 pounds. It will be noted that all working parts of this mechanism are lubricated by a continuous bath of oil.

The mechanism for operating the automatic cross-feed will be seen at the extreme right of the machine in Fig. 1. The pawl which operates the feed is moved by the horizontal lever, which, in turn, is actuated by the V bottom of the vertical shifting lever. Just beneath the horizontal lever there is an adjusting screw which governs the amount of motion of this lever. By turning this screw the action of

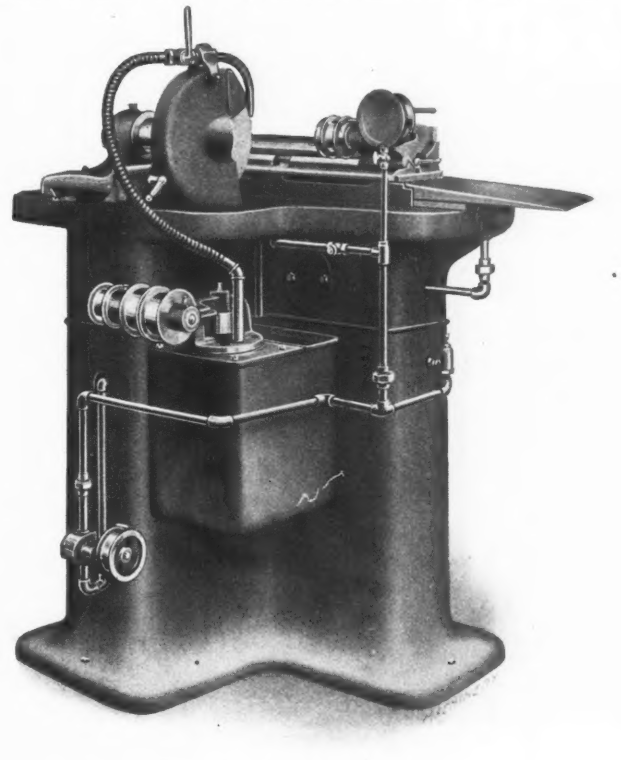


Fig. 2. Opposite Side of Machine shown in Fig. 1

the pawl may be regulated to enable it to pick up the required number of teeth on the ratchet wheel, each notch on which represents a movement of the head of 0.00025 inch. Revolving with the ratchet wheel there is a mechanism which is provided for the purpose of throwing out the pawl, thereby stopping the cross-feed when the work has been ground to the desired size. On the front of this mechanism there is a casehardened knob with a knurled edge, upon the face of which the figures "1" and "¼" are stamped. A little lever or key projects from this mechanism, and when the figure "1" is turned so that it is in line with the key, the depression of the key moves the mechanism 0.001 inch or four notches

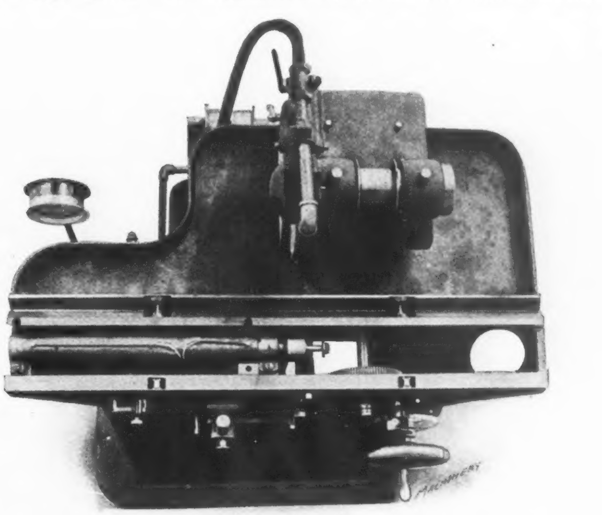


Fig. 3. Plan View of Greenfield Grinder showing Hydraulic Cylinder

of the ratchet wheel. When the knob is turned so that the figure "¼" is in line with the key, the depression of the key moves the mechanism 0.00025 inch or one notch of the ratchet wheel.

In practice, this would be used as follows: after one or two cuts have been made across the work, it is calipered and the

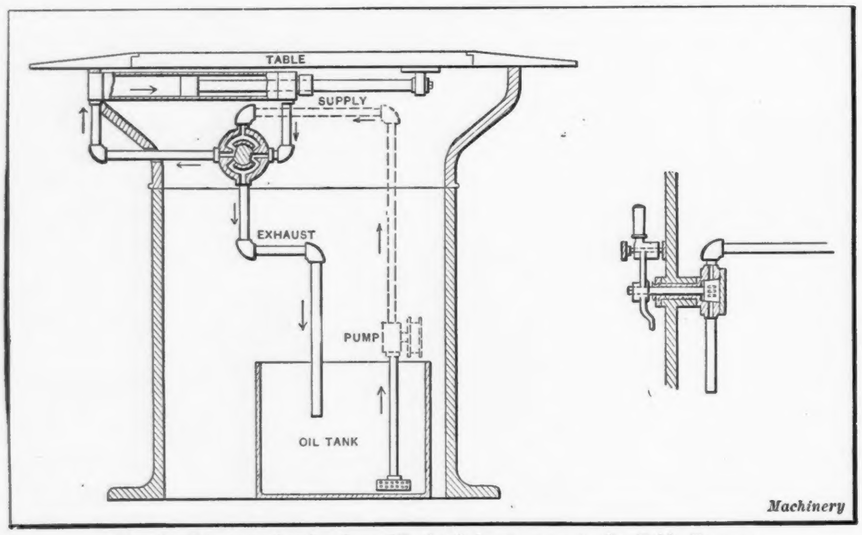


Fig. 4. Diagram showing how Oil circulates to operate the Table Traverse

amount of stock still to be removed to bring it to the desired size is determined. The mechanism is then brought around until the shield on the ratchet wheel touches the pawl; this shield is then set back the proper amount by depressing the key. For instance, suppose it is found that 0.0025 inch is still to be removed from the work. The shield mechanism is brought forward so that the shield just touches the pawl, after which the knurled knob is turned until the figure "1" is brought in line with the key. The key is then depressed twice, which will move the mechanism back 0.002 inch. The knurled knob is then turned until the figure "¼" is in line with the key and depressed twice more which will move the shield back 0.0005 inch. When this has been done the machine is again started and when the necessary 0.0025 inch has been removed from the work, the cross-feed will be automatically disengaged. In producing duplicate work, this device will have to be set only once and will then throw out on each piece at the same point so the required dimension is obtained. An occasional depression of the key in the "¼" position will take care of the wear on the wheel. A feature of this grinder is that all handles and levers for controlling the mechanism are within easy reach of the operator. Provision is made for delivering an ample supply of water for cooling the work, and the design has been worked out in such a way that the tendency of the water to be fanned away from the wheel is overcome. The principal dimensions of the machine are as follows: Extreme distance between centers, 12 inches; swing, 4 inches; maximum travel of table, 14 inches; diameter of grinding wheel, 10 inches; face of grinding wheel, ¾ inch; speed of wheel, 2100 revolutions per minute; number of work speeds, 3; floor space occupied, 70 by 29 inches; net weight of machine, 1335 pounds.

WARNER & SWASEY NO. 4 TURRET SCREW MACHINE

The Warner & Swasey Co., Cleveland, Ohio, has recently added to its line a No. 4 universal turret screw machine. The improvements incorporated are: the power longitudinal feed for the carriage, the arrangement on the carriage for chasing threads, and the fact that the carriage and turret are

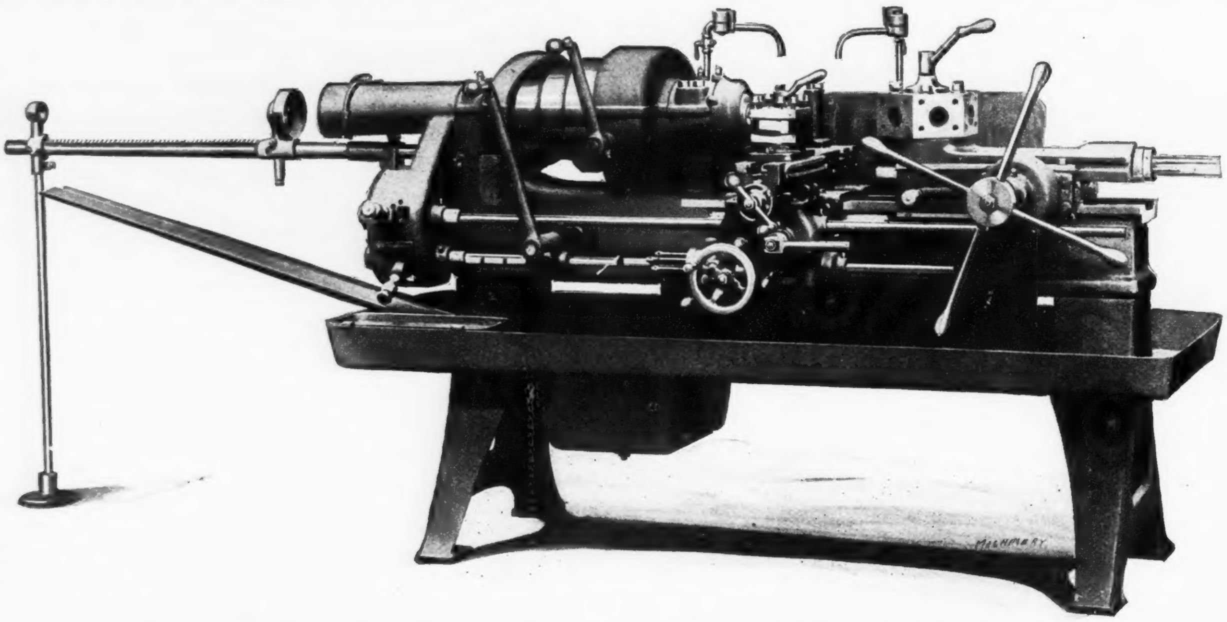


Fig. 1. Warner & Swasey No. 4 Universal Turret Screw Machine with Bar Equipment and Cone Pulley Drive

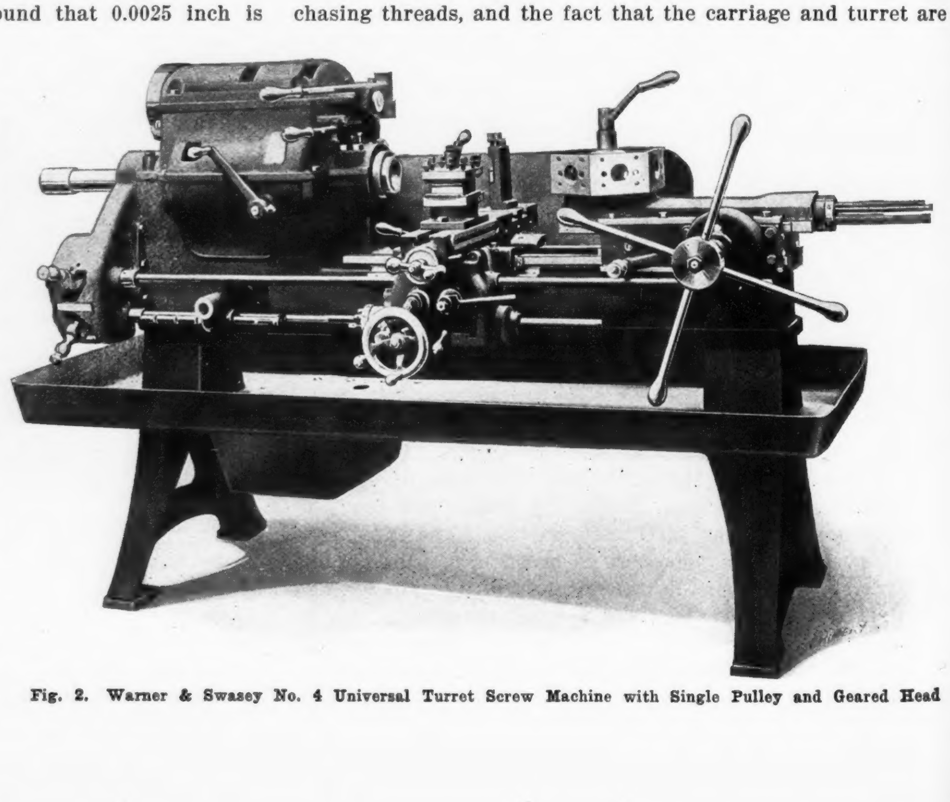


Fig. 2. Warner & Swasey No. 4 Universal Turret Screw Machine with Single Pulley and Geared Head

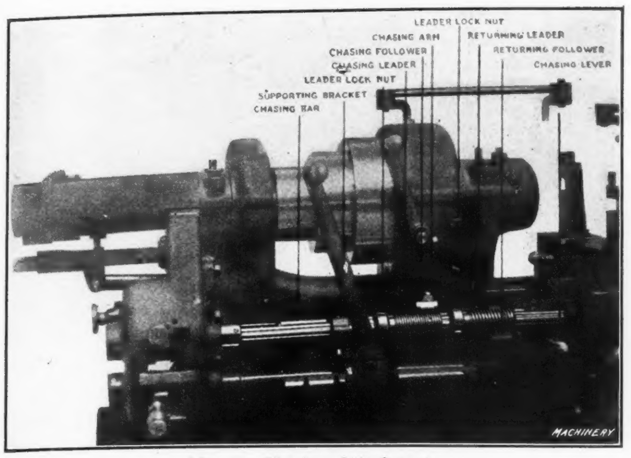


Fig. 3. Chasing Attachment

driven by separate shafts. These features add greatly to the efficiency of the machine and have been developed as the result of this company's wide experience in building turret screw machines.

For a long time screw machines have been built with power cross feed on the carriage, but this is the first machine to be fitted with power longitudinal feed. In order to add greatly to the possibility of working with the carriage, it is driven by a separate feed shaft. Another important feature is the fact that the feeds of this carriage can be reversed entirely independently of the feeds of the turret; thus, the turret can be fed toward the chuck while the carriage feeds away from the chuck if necessary. In this way, two di-

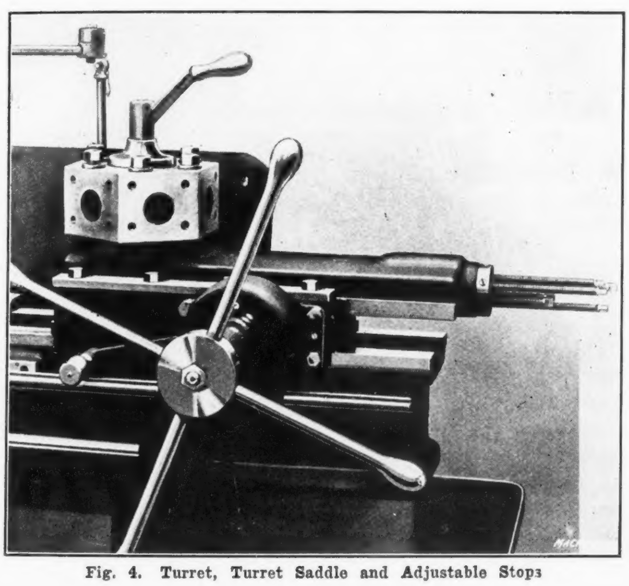


Fig. 4. Turret, Turret Saddle and Adjustable Stops

ameters can be turned at once, or the outside of a piece may be turned with the carriage while the hole is being bored from the turret. The longitudinal feed to the carriage has six independent adjustable stops for gaging the length turned. These stops trip the power feed and act also as dead stops.

To return to the chasing attachment: This is well shown by Fig. 3. By placing the chasing lever in its horizontal position, the chasing follower is brought into engagement with the chasing leader. When the thread has been chased the chasing lever is lifted, thus bringing the returning follower into engagement with the returning leader, and throwing the chasing follower out of engagement with its leader. As the returning leader and follower are threaded in a direction opposite to that of the chasing leader and follower, the carriage is thus returned to its starting point. It is not necessary to reverse the countershaft nor spindle for returning the chasing tool to its starting point. Each leader and follower cuts threads in multiples of 1 and 4 of its own pitch.

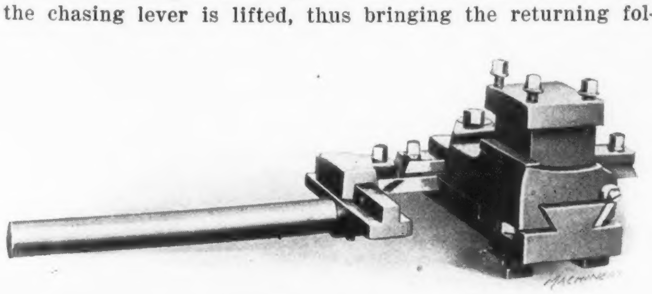


Fig. 5. Taper Attachment

The turret slide, shown in Fig. 4, has a length of feed of 10 inches, which is an extremely long travel for this size machine. It has also a very long bearing in its saddle. The saddle is provided with a supplementary taper base, and the slide is fitted with taper gibs on each side, these being fitted

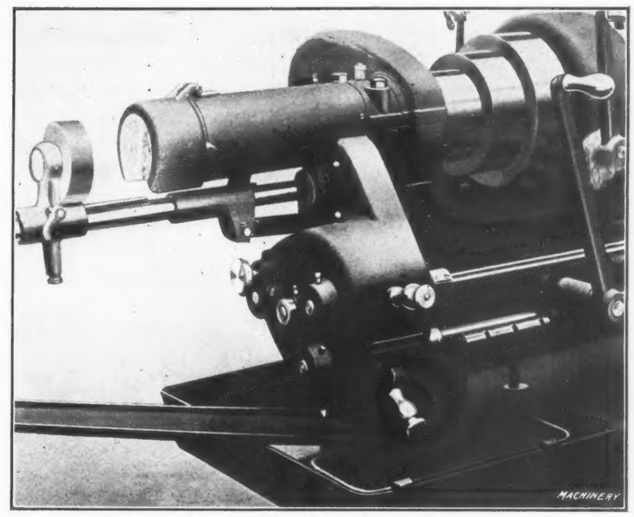


Fig. 6. Head—showing Cone Pulley and Feed Box

for realignment of the turret after it has worn slightly, although in the ordinary course of events it will not be necessary to adjust any of these parts for a very long time. The power feed to the turret is through a taper friction instead of the ordinary worm and worm gear.

Fig. 5 illustrates the taper attachment. The cylindrical arm of this attachment fits into a corresponding boss on the back of the bed. At the other end of the arm is the T-block, and the base of the attachment bolts into the T-slots at the

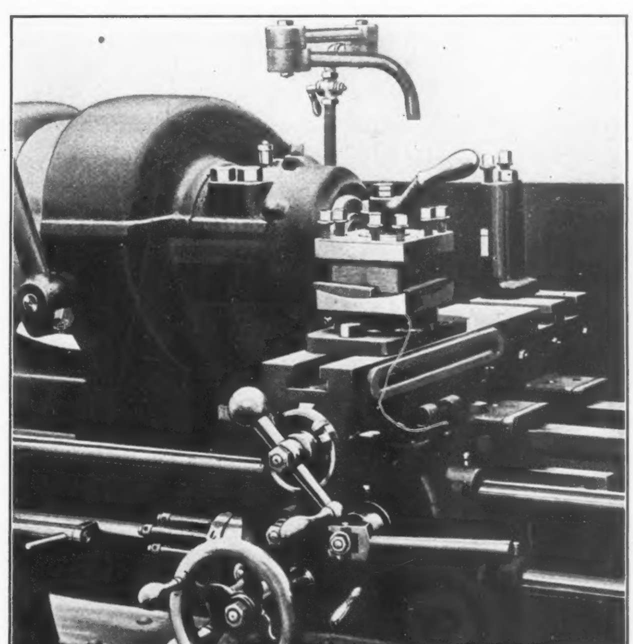


Fig. 7. Carriage with Cross-slide and Square Turret

rear of the cut-off slide. To this base is fitted the tool-block itself, this being, in turn, operated by the taper bar at the back, this taper bar being adjustable for tapers up to 3 inches to the foot. In doing taper work it is not necessary to disconnect the cross feed screw, inasmuch as the taper is not obtained from the cut-off slide itself, but from the tool-block of the attachment. This tool-block is arranged for either

inside or outside tapers. The taper attachment does not interfere with the operation of the turret or the square turret. Both cylindrical and taper work can be done on the same piece with the carriage, without removing the taper attachment.

The machine can be fitted with geared head, driven by single pulley as shown in Fig. 2 or with the three-step cone head shown in Fig. 6, the latter being the standard. The automatic chuck and wire feed handle bar stock up to 1½ inch capacity. The machine swings 16 inches over the bed and 8½ inches over the carriage cross-slide; the total longitudinal travel of the carriage is 17 inches and the cross travel, 8 inches; and the longitudinal travel of the turret is 10 inches.

WALDEN WRENCH

A recent product of the Walden Mfg. Co., Worcester, Mass., is a wrench for adjusting the reverse and brake pedal bands of the Ford automobile. This wrench is of exceptionally simple construction, being made of three pieces of steel which are secured together by four rivets. The head of the wrench is formed by a single piece of steel which is bent to the

Simple Form of Walden Wrench

required shape with the ends extended to form a handle. Two center pieces are held between the ends which form the outsides of the handle. The forward ends of these center pieces are bent so that they form one angle of the "hex." The peculiar shape of the handle is for the purpose of providing the necessary clearance, and the Walden Mfg. Co. is prepared to make wrenches of this type of a form which will give the necessary clearance around the nuts of other machines.

"SATCO" DRILL HOLDER

The Steel-Art Tool Co., Machinery Hall, Chicago, Ill., is now manufacturing the "Satco" safety drill and tool-holder

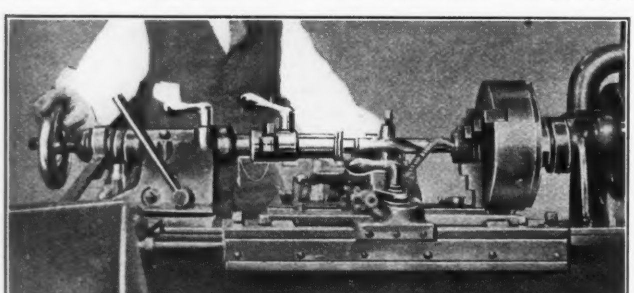


Fig. 1. "Satco" Drill Holder performing a Drilling Operation

for lathes, four applications of which are shown in the accompanying illustrations. This tool will hold taper, square and straight shank drills, taps, reamers, boring-bars, and various other lathe tools. It is quickly attached to or detached from the machine, and the tool can be instantly re-

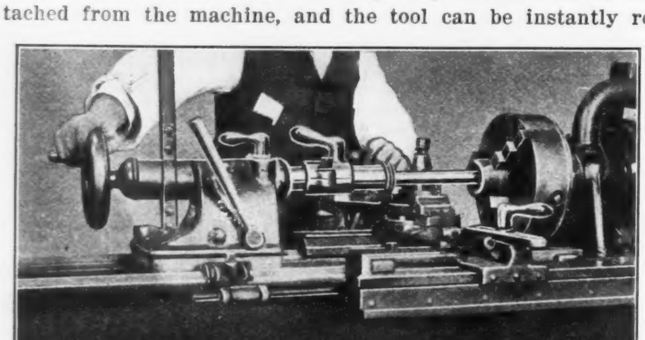


Fig. 2. Boring-bar held in the "Satco" Drill Holder

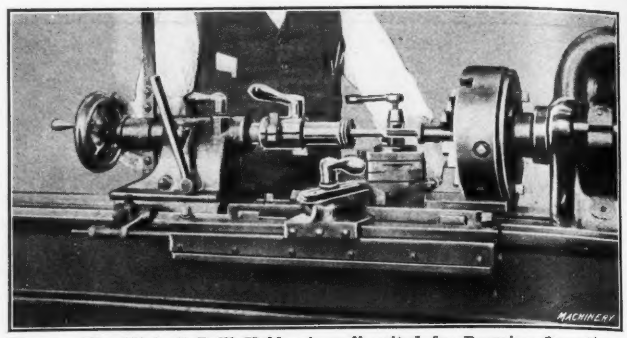


Fig. 3. The "Satco" Drill Holder is well suited for Reaming Operations

leased from the holder without requiring the use of a hammer and drift.

Referring to the illustrations, it will be seen that the holder is provided with a split bushing which fits over the tailstock spindle. With the tool-holder in place on the spindle, the cap-screw is tightened to bind this bushing in place. The tool fits in a socket at the opposite end of the holder and when it is required to remove it, it is merely necessary to turn the small lever on the holder. This draws a wedge up against the end of the tool shank and forces it out of the socket in the holder. This arrangement forms a substitute for the

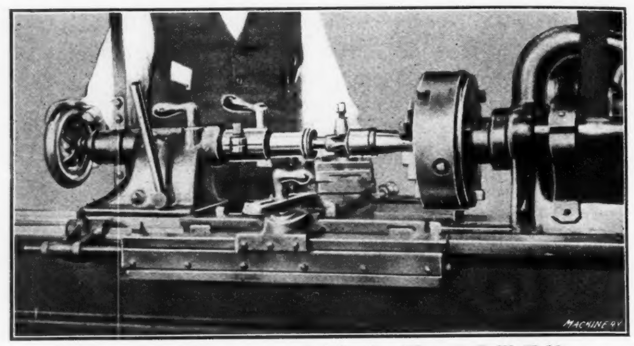
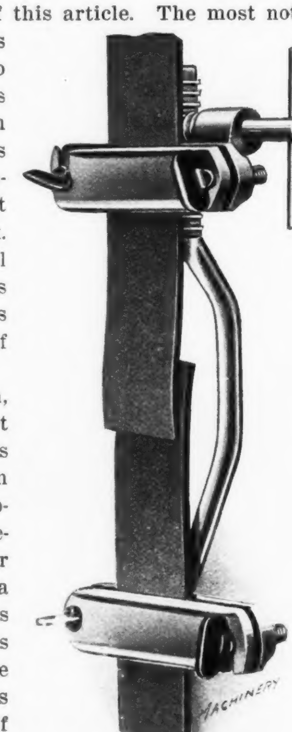


Fig. 4. Taper Reamer mounted in the "Satco" Drill Holder

use of a drift and hammer and eliminates the possibility of accidents which occasionally occur in removing tools in this manner.

SOUTHWICK "LITTLE GIANT" BELT TIGHTENER

The George W. Southwick Co., 35 Warren St., New York City, has recently brought out the "Little Giant" belt tightener which forms the subject of this article. The most noteworthy feature of this device is that the belt can be brought to the proper tension and the ends fastened while they are held in position over the pulleys. This eliminates all guesswork in regard to the amount to be cut out of the belt to take up the slack. Another feature is that the pull exerted by this device comes centrally so that the tension is uniform and draws the ends of the belt squarely together.



Southwick Belt Tightener

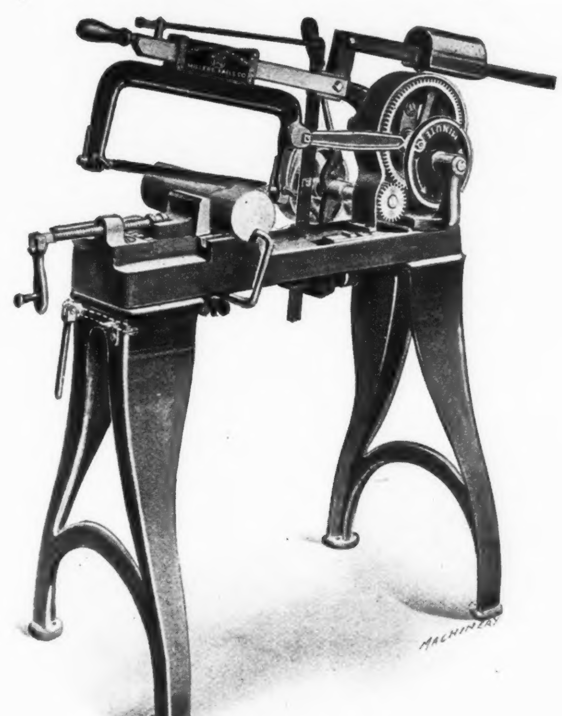
Referring to the illustration, it will be seen that this belt tightener consists of two clamps which are secured in place on the belt by means of thumb-screws, one of these clamps being stationary while the other may be adjusted by means of a rack and pinion. The gear is turned by a worm which is operated by the handle at the top of the tightener. By this means the required tension of the belt is obtained. These belt tighteners are made in four sizes

with capacities for belts up to 4, 6, 10 and 14 inches in width.

The location of a belt does not affect the efficiency with which a fastening can be made, and it is claimed by the manufacturers that this tightener can be adjusted to the belt and the belt drawn to the required tension and made ready for the fastening in less than three minutes. An important feature of this device is the offset in the draw-bar which permits of the use of a block for hooks and a clamp for cemented joints. The manufacturers of this tightener believe it will be greatly appreciated by those who use the wire hinge joint for fastening the ends of their belts, from the fact that before the belt is removed from the pulley the proper amount to be removed can be determined and when the belt is replaced on the pulley the ends can be drawn together and the rawhide fastening pin can be quickly inserted through the interlocking wire loops.

MILLERS FALLS POWER HACKSAW

The Millers Falls Co., Millers Falls, Mass., is now building the No. 90 "Star" power hacksaw which is illustrated herewith. This machine is equipped with a geared drive which gives an exceptionally uniform cutting stroke and a quick return stroke. The saw is returned at twice the cutting speed. The usual provision is made for lifting the saw clear of the work on the return stroke and an attachment



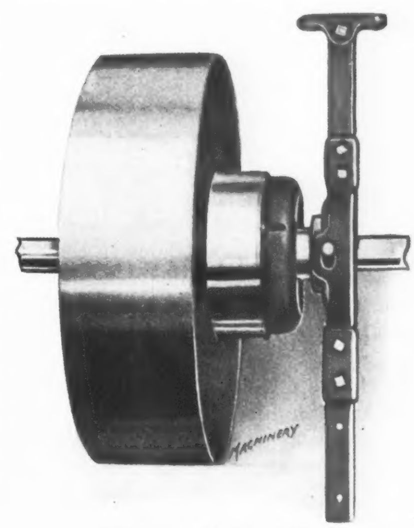
Millers Falls No. 90 Power Hacksaw

is provided which enables the saw to be suspended above the work when it is necessary to make measurements or to adjust the position of the work in the vise. By simply turning a small lever, the operator is able to lift the saw out of engagement with the work for the purpose of making such measurements or adjustments. Another feature of this machine is a support on the cut-off side which prevents the material from dropping when the cut is nearly finished. An adjusting screw in the head provides for taking up wear on the arm and the vise nut in the bed is removable so that it may be replaced when necessary. The working parts of the machine are located under the bed where they are protected from dust and dirt. The machine stops automatically when the cut is completed.

The principal dimensions of this power hacksaw are as follows: ratio of back gears, 3 to 1; height from floor to top of bed, 28 inches; floor space occupied, 20 by 46 inches; suitable speed, 60 strokes per minute; size of driving pulley, 6 inches in diameter by 2 inches face width; cutting capacity of machine, 5 by 5 inches; length of blade, 12 inches; net weight of machine, 215 pounds.

EDGEMONT FRICTION CLUTCH

In the December, 1912, number of MACHINERY, the plate type friction clutch manufactured by the Edgemont Machine Co., 2700 National Ave., Dayton, Ohio, was illustrated and described. Since that time this company has brought out an enclosed friction clutch which forms the subject of the present description. This clutch was designed to meet the demand for a powerful friction clutch of simple design that could be adjusted without removing the cover and still have none of the parts exposed in a way which would make them likely to catch belts or the clothing of men employed to look after the shafting.

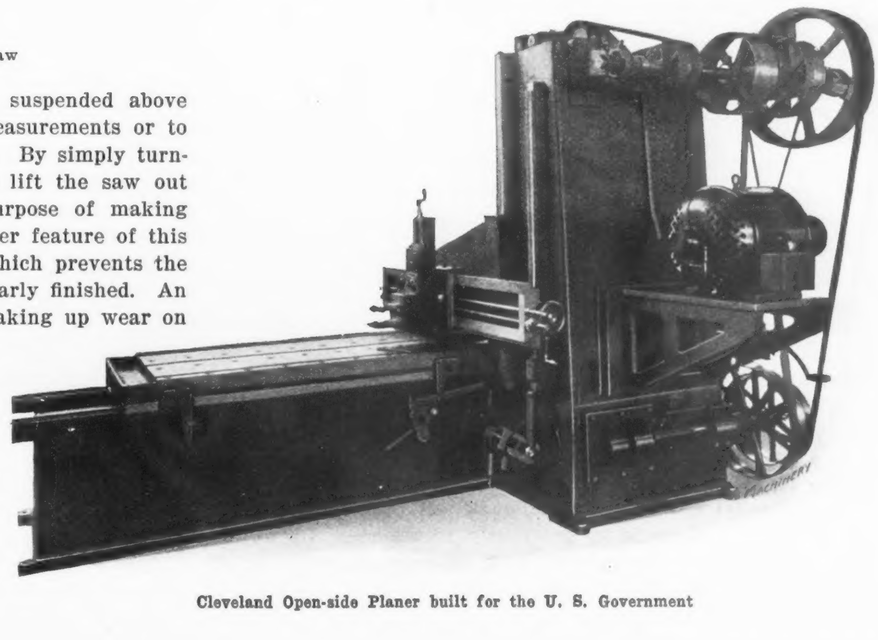


Edgemont Friction Clutch

This new Edgemont clutch is equipped with an improved expanding type of friction with metal-to-metal contact. Ample provision is made to adjust for wear and the sleeves are made in sizes to provide for using them in connection with standard wood or steel pulleys, rope sheaves, sprocket wheels or gears. These clutches are made in fourteen different sizes which have a range for transmitting from 2 to 25 horsepower.

CLEVELAND OPEN-SIDE PLANER

The Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, Ohio, has recently built a special open-side planer for use on the United States Government torpedo boat destroyer, tender No. 2, *Melville*. The installation of this planer between decks made it necessary for the over-all height not to exceed 8 feet 5 inches, which is 16 inches lower than the height of the regular 36-inch machine of this type. The design was finally worked out in such a way that the



Cleveland Open-side Planer built for the U. S. Government

machine was built to meet the requirements and still have the full planing capacity of the standard machine.

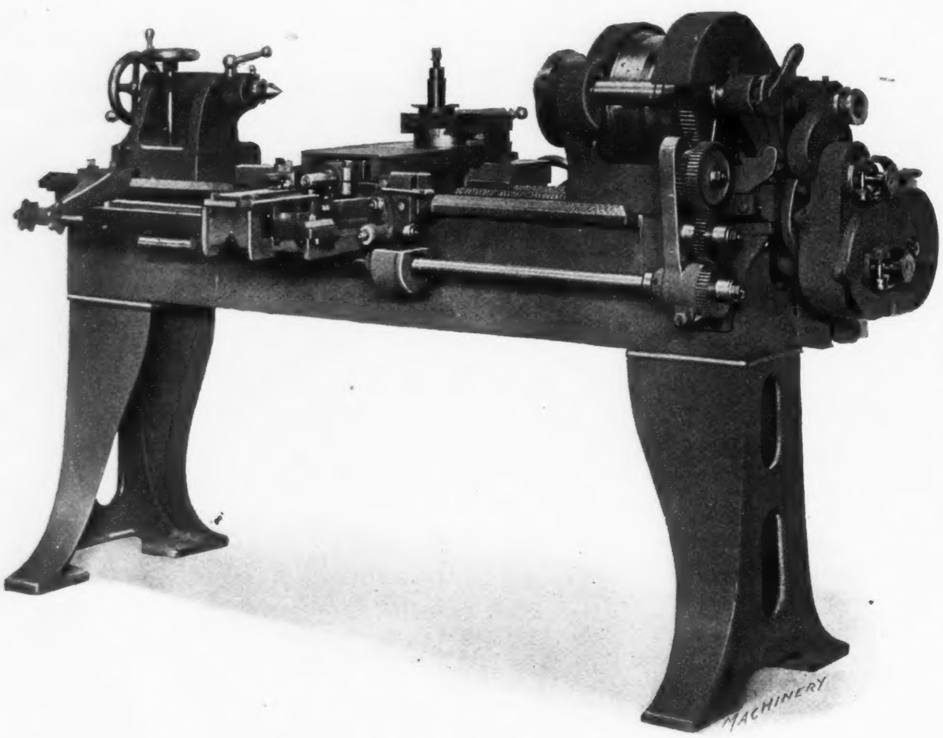
Owing to the weight of the Cleveland open-side planers, no provision is necessary for bolting them to the foundation when set up under normal conditions. In the present case, however, it was necessary to provide for anchoring the planer owing to the roll of the ship. Referring to the illustration, it will be seen that power is provided by an individual electric motor which was built by the Reliance Electric & Engineering Co. under government specifications.

WHITCOMB-BLAISDELL RELIEVING ATTACHMENT

The Whitcomb-Blaisdell Machine Tool Co., 134 Gold St., Worcester, Mass., is now equipping lathes of its manufacture with the relieving attachment shown in the accompanying illustration. The features of this equipment are that it is of simple design, that it can be used for relieving either spiral or straight fluted cutters, and that the full range of the compound rest is available in connection with the attachment.

Referring to the illustration, it will be seen that the relieving attachment is geared to the lathe head by a train of spur gears carried by a suitable bracket. Change gears are provided so that for each revolution of the lathe spindle the relieving attachment makes anywhere from three to twenty-seven strokes. By compounding the gearing, the tool may be made to lag sufficiently for relieving spiral fluted cutters.

The horizontal shaft carries a cam as shown, and as the shaft rotates, this cam rocks the bellcrank on the relieving attachment. This bellcrank, in turn, rocks a second crank which is carried on the end of the transverse shaft. The oscillation of this shaft is transmitted through a pair of bevel gears to a small vertical spindle, at the upper end of which there is a disk almost half of which has been milled away. The flat side of this disk contacts with a pin in the tool-slide, and as the shaft oscillates the disk causes the slide to be moved forward. The movement of the slide is against the tension of a spring and when the shaft oscillates back—thus releasing the pressure of the disk on the pin in the slide—the slide and tool are withdrawn from the work. As the power to the vertical spindle carrying the disk is through bevel gears, it is possible to set the compound rest to any required angle as previously mentioned. By adjusting the throw of the cranks which operate the relieving attachment, the amount of relief can be varied as required.



Relieving Attachment for Whitcomb-Blaisdell Lathes

BESLY NO. 41 DISK GRINDER

The accompanying illustration shows an improved direct-connected motor-driven disk grinder developed by Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., and designated as the No. 41 Besly grinder. Heretofore, disk grinder bearings have usually been grease lubricated, owing to difficulty in automatically lubricating the thrust bearings with liquid oil. In this new grinder, the Besly Co. has worked out a system of ring oiling for both the radial and thrust bearings. Owing to the extremely severe duty and accuracy required of the modern disk grinder, the design and construction of the spindle and its mountings is especially important. In the manufacture of the No. 41 Besly grinder the motor is equipped with special end castings carrying extra large bearings suitable for disk grinder service. All wearing parts are renewable. The rotor shaft is of hard crucible machine steel, the wheel collars are drop-forged from hard crucible steel, and the bearing bushings are cast iron, lined with high-grade bearing metal. These bushings are ground over the outside and carefully fitted into bored and reamed holes in the motor end casings, so that new bearings may be inserted when necessary, without affecting the alignment of the spindle.

Charles H. Besly No. 41 Disk Grinder

End thrust in both directions is taken on hardened and ground tool steel thrust collars of large area, running at each end of the right-hand bearing bushing. End play of the spindle is taken up on these thrust collars by means of adjusting collars which are threaded on the spindle. With this construction the heating of the bearings when running does not tend to tighten and bind them, because the longitudinal expansion from heat is greater in the spindle than in the bearing bushing. However, the expansion is so nearly uniform that the change in adjustment due to temperature changes is practically nil. Therefore this machine can be run safely with all end play

taken up, providing for the grinding of work within closer limits. The motor is 7½ horsepower, running fully enclosed for alternating current. When operating on 60 cycle current, this machine carries 20-inch disk wheels and runs 1200 R. P. M. When operating on 25 cycle current, the machine runs at 1400 R. P. M., and is equipped with 18-inch disk wheels to give the correct abrasive speed. The machine may be equipped with any type of work table. As illustrated, it carries on the right a geared lever feed table and on the left a plain tilting table. It is started and stopped by means of a single-throw switch located inside of the base casting. The floor space occupied is 28 by 28 inches and the weight of the machine with all equipment is 2000 pounds.

REED-PRENTICE AUTOMATIC LATHE FOR STRAIGHT TURNING AND FACING

An automatic lathe for straight turning and facing operations on forgings and castings, which was recently built by the Reed-Prentice Co., Worcester, Mass., for the Ford Motor Co., is shown in Fig. 1. These machines are of unusually rugged construction to insure an absolute absorption of vibration and to withstand the severest service which can be demanded of machines of this type. The power is in excess of any demand made upon the lathe. The wide double belt drives to a large diameter pulley, and then through a pair of herringbone gears running in oil, to the main head spindle. This arrangement gives a constant spindle speed, no mechanical changes being provided. A feature of these lathes is the one-feed and one-speed idea which guarantees a maximum production when the machine has been set at the proper feed and speed for a given operation. Change gears can be used if desired to vary the feed to suit the class of work, although when once set up the feed is rarely changed. In order to obtain the desired spindle speed the countershaft speed must be changed accordingly.

The object of this machine is to furnish a second operation machine that will produce a large quantity of work which will be equal in quality to that produced on the best types of engine lathes. In the construction of this machine careful consideration has been exercised in the distribution of material. The head spindles are made of heat-treated chrome-nickel steel, the bearings are hardened and run in phosphor-bronze journals, and sight-feed oilers are used for lubrication of all head bearings. The driving pulley which is mounted on a shaft at the rear of the head, and which arrangement entirely eliminates any belt tension on the main spindle, is well guarded to protect the operator, the same guard entirely covering all end works gearing.

The tailstock is extremely rigid, being of the four-bolt type. It is made in one piece in preference to the regulation two-piece tailstocks, as this prevents any chance of sideways shift of the tail spindle. The carriage and apron are also very

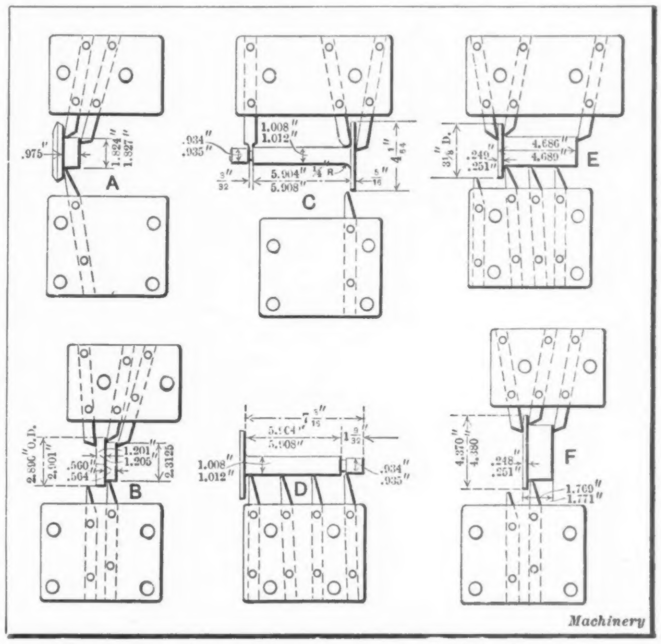


Fig. 2. Examples of Work done on the Reed-Prentice Lathe

heavily constructed, the rack pinion being made of hardened steel, engaging with a hardened rack on the bed. A cam feeding-in attachment is incorporated in the construction of the apron and carriage, which arrangement constitutes an adjustable bracket on the side of the bed carrying cam surfaces, and a link motion inside of the apron that transmits a cross-feed action to the front tool-block. The longitudinal travel of the carriage causes the link motion and cam surfaces to deliver this feed-in motion to the block, feeding the tools into the work to a predetermined diameter.

The back arm facing device is an attachment mounted on a large shaft or bar, which is supported in bearings cast integral with the head and tailstock, and bored in perfect alignment with the main spindles. A cam attached to the rear of the carriage actuates the bar by means of a roll carrier arm which projects from the bar, and is in contact with the cam surface. The longitudinal travel of the carriage which carries the rear cam causes a rotating motion to the bar, and this motion feeds the facing tools in toward the center of the spindle. It will be noted that the longitudinal travel of the carriage actuates both the feeding in of the front tools and the feeding in of the facing tools. When the work is completed the feed is automatically tripped, and the carriage and all tools almost instantly return to their starting position.

The complete cycle of operations on a piece is as follows: The work mounted on an arbor is placed between centers, the countershaft started, and the feed latch lifted into position. Both feeds are thus started, the work progressing until all diameters are turned and all shoulders and ends faced down, after which the feed is automatically tripped, and all tools return to their starting position. This completes the cycle of operations, and the machine is then ready to receive another piece

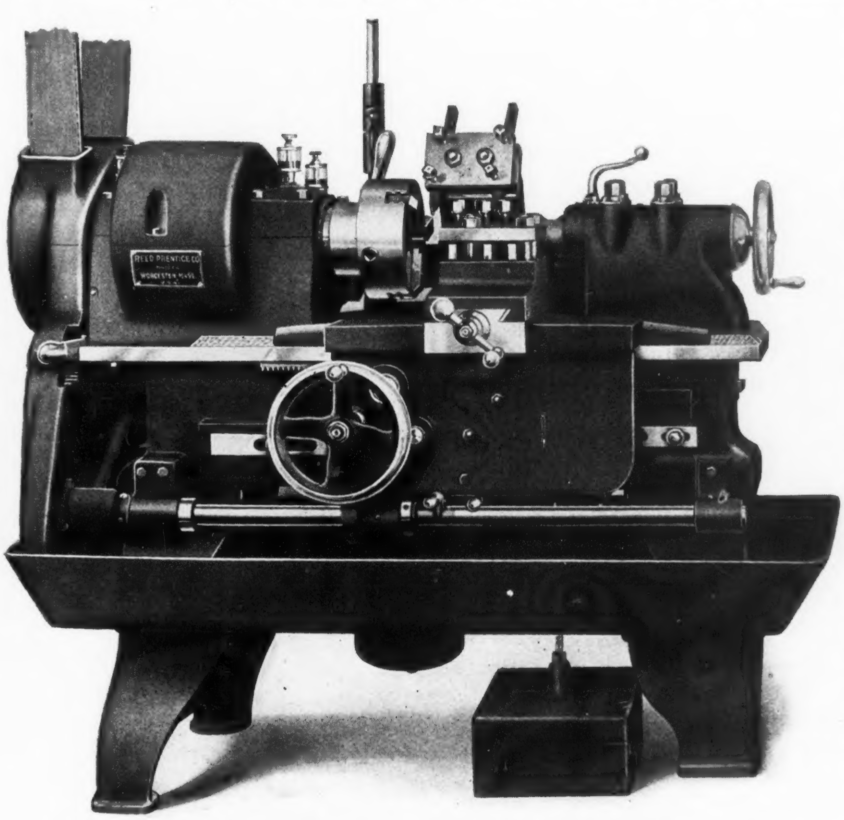


Fig. 1. Reed-Prentice Automatic Lathe for turning and facing Forgings and Castings

which has already been pressed on another arbor. Thus it will be seen that it is quite possible and practical to permit one operator to have charge of two or more machines. It will be noted from Fig. 1 that the entire machine is very compactly designed to eliminate any spring due to long arbors or excessive overhang of tail spindle. The floor space occupied is 5 feet by 3 feet 4 inches.

Figs. 2 and 3 illustrate the adaptability of the machine to the usual run of work. It happens that the pieces shown are all steel forgings and in most cases the production obtained on this new Reed-Prentice lathe has been practically double that previously obtained. Referring to Fig. 2, at *A* the hub and back of the bevel gear blank are finished, three tools being provided for this purpose—two tools for facing and one for turning. The actual time required to finish these pieces is ½ minute. The steel gear blank shown at *B* is turned and faced with three tools for facing and two tools for turning. The actual time required to finish these pieces is also ½ minute.

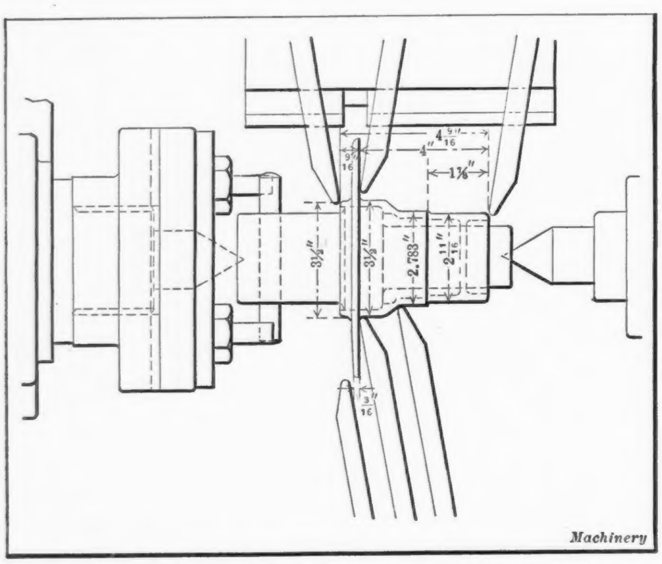


Fig. 3. Machining a Wheel Hub on the Reed-Prentice Lathe

The flange of the piece shown at *C* is turned and faced and the stem notched as shown, in 1½ minute. The stem is turned in a previous operation, while the flange is held in the chuck and the stem supported on centers. Four tools are used for this turning operation as shown at *D* and the time required is 45 seconds. Another example of turning and facing is shown at *E* where it will be seen that three turning and three facing tools are employed. This piece is finished in 1¼ minute. A somewhat similar operation is illustrated at *F*, in which three facing tools and two turning tools are employed. The time required to finish this piece is 1¼ minute. Fig. 3 shows the way in which a wheel hub is turned and faced on the Reed-Prentice automatic lathe, the actual time required to finish this hub being 2½ minutes. These are merely examples of work which tend to show that this type of lathe is adaptable for use in the production of small pieces in a great number of factories.

MARVIN & CASLER CENTER INDICATOR

A rotary center indicator particularly adapted for use on the Casler offset boring head has recently been placed on the market by the Marvin & Casler Co., Canastota, N. Y. This instrument is designed to indicate the center of any rotating spindle or shaft. It is small, compact and strongly built so that it is not likely to be injured by careless handling. When used in connection with the Casler offset boring head, it enables the operator to locate holes without removing the boring head from the spindle of the machine.

The indicator consists of a shank *A* which is gripped in the chuck of the boring head or a draw-in collet in the spindle. A pointer *B* is held against the faceplate *C* by means of a spring carried in the shank of the tool. The contact surfaces between the pointer and faceplate are hardened, ground and lapped to an accurate finish. The pointer is free to float in any direction over the surface of the faceplate and the head *D* is ground to a diameter of 0.250 inch. When used in the chuck of a boring head, the chuck is first

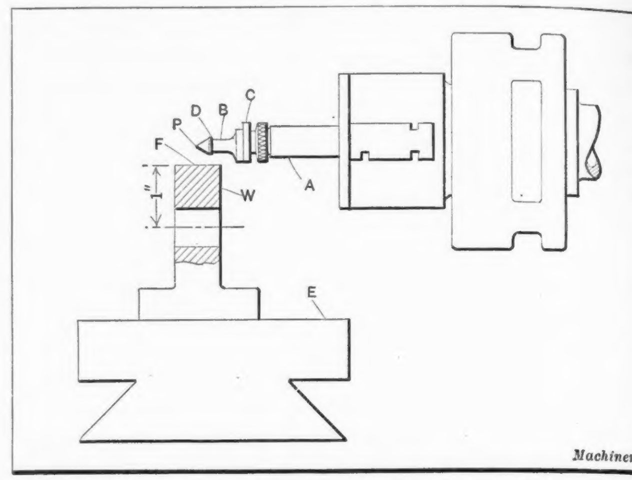


Fig. 1. Diagram showing how Marvin & Casler Center Indicator operates

brought concentric with the head. It is not necessary to have the shank of the indicator run true, as it is designed to operate satisfactorily without paying attention to this point. The pointer *B* is next brought in contact with a finished surface *F* near the center of the hole which is to be bored, after which the pointer *B* is moved to one side of the faceplate *C* so that it will describe a circle when the spindle is rotated. With the spindle rotating, the table *E* carrying the work *W* is slowly raised. Under these conditions, the head *D* of the pointer will strike the finished surface *F* of the work and be forced back toward the center of the faceplate *C*. The distance which the head is forced back at each revolution becomes less as the work is raised, until the pointer has finally been brought to the exact center of the faceplate *C*.

The operator continues to raise the table until the pointer runs true, *i. e.*, does not recede from the work. The graduated dial indicating vertical movement of the table can now be set to zero and as the diameter of the head *D* is exactly 0.250 inch, the table can be raised ⅛ inch, which will bring the center of the spindle in line with the finished surface of the work. For the case shown in the illustration, a further movement of 1 inch will bring the spindle on a horizontal line, passing through the center of the hole to be

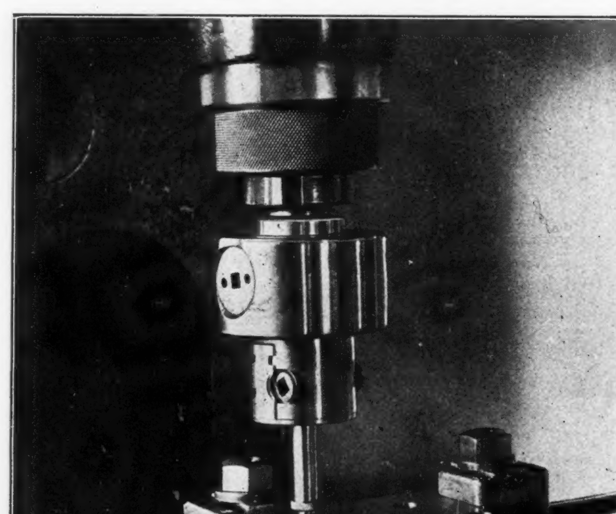


Fig. 2. Marvin & Casler Center Indicator in Place on the Machine

bored. It will be evident that lateral distances can be determined in a like manner by setting the pointer *B* to engage with any vertical finished surface on the work.

NEW MACHINERY AND TOOLS NOTES

Autogenous Welding Outfit: Tolman Mfg. Co., Boston, Mass. An equipment consisting of the usual pair of oxygen and acetylene cylinders connected to a cutting torch.

Pipe Cutter: Borden Co., Warren, Ohio. A pipe cutter in which the frame of the tool clamps onto the pipe. The cutters are carried in a ring and are fed in by spring pressure as the ring is revolved about the pipe.

Drop Hammer: Henderson Machine Co., 5032 Germantown Ave., Philadelphia, Pa. A steam- or air-lift drop hammer adapted for the rapid handling of work where it is necessary to raise the hammer a slight amount and drop it repeatedly.

Combination Vise and Drilling Machine: Diamond Expansion Bolt Co., 90 West St., New York City. A tool known as the "trident" combination drill press and vise which consists of a vise, anvil and a drilling machine mounted on a swivel base.

Rack-cutting Attachment: Kearney & Trecker Co., Milwaukee, Wis. A milling machine attachment adapted for milling racks, sawing off stock, milling slots which have to be accurately indexed, cross-milling operations and similar classes of work.

Graphite Lubricant: Lumen Bearing Co., Buffalo, N. Y. A semi-fluid graphite lubricant prepared in such a way that the graphite is held in suspension when mixed with lubricating oil or grease. This product has been given the trade name of "Lesoyl."

Offset Pliers: H. D. Smith & Co., Plantsville, Conn. Slip-joint offset pliers which are drog-forged and made with a serrated opening between the jaws. The gripping surfaces at the ends of the jaws are checkered and there is a wire cutter at the rear.

Bending Machine: Garrison Brass & Machine Works, New York City. A machine for cold-bending rods or tubes of steel or brass. The machine is also applicable for use in bending band iron into different forms for handles, coils, hooks and similar parts.

Punching Machine: Cleveland Punch & Shear Works Co., Cleveland, Ohio. An open-gap punching machine of unusually heavy construction which was built for the Cambria Steel Co. The machine will be used in the fabrication of splice bars and tie plates.

Die Cutting Machine: Alfred H. Schütte, New York City. In operating this machine a light sheet-metal templet the shape of the die to be cut is secured on top of the die blank. This serves as a guide for the cutting tool which is made with a single relieved cutting tooth.

Hydraulic Press Valve: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. A pilot-operated hydraulic press valve for use in operating high-pressure hydraulic presses where a very large volume of water is required. The valve is controlled by two small pilot valves.

Drilling and Boring Machine: Pawling & Harnischfeger Co., Milwaukee, Wis. A horizontal drilling and boring machine which has a working area of 60 square feet. The design follows the general lines of the No. 3 machine which has been built by this company for some time.

Washer Making Machine: Joseph M. Mason Machine Co., Philadelphia, Pa. A washer making machine provided with a carrier plate that removes the product after it has been stamped. In addition to cutting washers, the machine is suitable for making various small hardware specialties.

Motor-driven Planer: Niles-Bement-Pond Co., 111 Broadway, New York City. A 72-inch planer equipped with electric motors for operating the feed mechanism and power traverse of all the heads. This machine is equipped with the Niles-Bement-Pond Co.'s standard reversing motor drive.

Gear Testing Machine: Feicht-Bevington Mfg. Co., Cleveland, Ohio. A machine for testing the accuracy of gears. Readings can be made to 0.0005 inch and the dial graduations are large so that they are easily read. The multiplying levers of the indicators on this machine have a ratio of 250 to 1.

Boring Tool: Allen & Curtiss, South Bend, Ind. A boring tool intended for use on the lathe, milling machine or drill press, which is provided with simple means of adjustment. The body is slotted to receive the cutting tool which is adjusted by two set-screws tapped into the body at the ends of the slot.

Muffle Furnace: Eclipse Fuel Engineering Co., Rockford, Ill. A vertical muffle furnace for heating high-speed steel tools. The muffle is 5 inches inside diameter and 11¼ inches high. The furnace is heated by six burners which deliver the heat to the annular space between the muffle and the lining of the furnace.

Die-sinking Machine: Jackson Machine Tool Co., Jackson, Mich. A duplex die-sinking and cherrying machine which was formerly manufactured by the Melling-Northrup Co. and taken over by the present builders about six months ago. Numerous improvements have been made which add to the efficiency and durability of the machine.

Elevator Guide Planing Machine: Niles-Bement-Pond Co., 111 Broadway, New York City. A planer designed for machining elevator guides. It measures 52 inches between the housings and the maximum distance from the table to the cross-rail is 18 inches. The table is 20 feet long and material ranging from 2 to 6 inches in height can be accommodated.

Electric Annealing Furnace: Electric Furnace Co. of America, Alliance, Ohio. An electrically-heated furnace for use in annealing brass and German silver blanks. The framework is made of steel and is 15 feet long by 8 feet wide by 7 feet 6 inches high. Doors are provided at both ends of the furnace and a mechanical pusher actuated by compressed air operates the charging mechanism.

Multiple-spindle Chucking Machine: C. M. Conradson, Madison, Wis. A hydraulically-operated six-spindle automatic chucking machine for boring and turning operations. It is equipped with tools for cutting both vertically and horizontally, and has a wide range. Both the spindle speeds and feeds may be changed at any time while the machine is under cut, which is an especially valuable feature when operating on pieces of large diameter.

Manufacturing Lathe: Greaves-Klusman Tool Co., Cincinnati, Ohio. An automatic machine in which the use of cam drums or pins for moving the tool-slides has been eliminated. The feed movement is secured through large diameter screws of coarse pitch which work in long nuts set close to the guides. The shifting mechanism which controls the feeds, speeds and indexing is operated by dogs on a drum which shift levers connected to positive clutches.

Grinding Machine: Landis Tool Co., Waynesboro, Pa. A grinding machine designed with a stationary work-table and a traversing grinding wheel. Wherever possible, ball bearings have been used in preference to plain bearings, and forgings have been used in place of castings for those parts of the machine which are subjected to severe strains. The grinding spindle runs in bearings which are self-adjusting to compensate for expansion due to an increase of temperature. These bearings can also be adjusted to take up wear. These machines are built to swing 10 and 12 inches and to take from 18 to 96 inches between centers.

* * *

SWEDISH ENGINEERING CONVENTION IN THE UNITED STATES, 1915

Plans are being made for a meeting or convention of Swedish engineers visiting the United States in 1915 on account of the San Francisco Exposition and engineers of Swedish birth permanently residing in this country. The meeting will be held in early September in Chicago, where papers will be read by visiting engineers as well as by resident members of the organization. All engineers of Swedish birth are invited to enroll. The fee for enrollment is $5. The secretary of the Eastern Organization Committee is Erik Oberg, associate editor of MACHINERY; home address 185 Sixty-eighth St., Brooklyn, N. Y. The chairman of the committee is C. J. Mellin, consulting engineer, American Locomotive Works, Schenectady, N. Y.

* * *

The Marconi Telegraph-Cable Co. in connection with the Marconi Wireless Telegraph Co. of America, has announced that the Marconi high-power trans-oceanic stations now being constructed in the vicinity of New York are nearing completion, and that public messages for direct wireless transmission between the United States and Great Britain and Ireland will be accepted soon. The tariff for full rate marconigrams will be seventeen cents a word, and for the other classes of service the wireless rates will show a corresponding reduction from regular cable rates.

* * *

The forest departments of the states of Washington and Oregon intend to discontinue the use of barbed wire for fences. The claim is that barbed wire has no advantage over smooth wire, that it injures stock, and that it is more likely to be broken down by snow. Stockmen in Oregon, who recently constructed fences of smooth wire with some misgivings, now say that they will never use barbed wire again.

G. E. HIGH VOLTAGE OUTDOOR OIL SWITCHES

The general principles of operation of indoor and outdoor oil switches are the same, but some of the details of construction are obviously different. In addition to performing the usual duties, the outdoor switch must be so constructed that successful service will result while exposed to the effects of the severest weather; neither rain, snow nor sleet should be able to interfere with satisfactory operation. All moving and operating parts must be totally enclosed and fully protected. The Type F, Form K-22 oil switches illustrated herewith meet these conditions fully. They are built in single-pole elements and are operated by hand, solenoid or air. The mechanism for each element is self-contained and mounted on the top of a steel tank. The switches trip free from the operating mechanism, so that the automatic switches cannot be held closed on overload or short circuits; and all the switches, non-automatic or automatic, are always opened at the same quick rate of speed. The standard hand operating lever consists of a removable wooden handle attached directly to the switch mechanism. This handle is removable to guard against unauthorized operation. The solenoid mechanism is similar to the hand mechanism, except that a direct-current solenoid with a rod for connecting to the mechanism is used instead of the operating handle. The air-operated mechanism is rather special and needs individual consideration.

Since the insulating properties of oil are superior to those of air, the bushings are inserted through the cover at an angle converging at the lower end, which materially reduces the size of the oil tank necessary for any given voltage. The bushings extend below the oil level down to the stationary contacts of the switch, and an iron cap forms the top of the bushing. The bushings are supported by metal clamps bolted to the tank cover and may easily be removed for inspection or repair. The contacts are of the well-known "sliding-wedge" construction. Each phase contains two contacts in series. The stationary ones consist of widely flared fingers and extra long arcing tips of drop-forged copper. The movable element of the contact is a wedge-shaped copper blade.

Fig. 1. Triple Pole Single Throw Oil Switch for 300 Amperes at 22,000 Volts

This blade moves in a vertical plane, being drawn up by the switch mechanism when the switch is closed and dropped by gravity assisted by springs when the switch opens. As the wedge-shaped movable contact enters the stationary flared contact, a steady and increasing pressure is exerted on the contact surfaces, which insures good contact, especially since these surfaces are kept clean and bright by a rubbing motion each time the switch operates. By the use of the sliding wedge contact, the arcing set up by opening the switch under load occurs between the extended portion of the stationary contact fingers and the upper extremity of the movable blade, which sections are not in contact when the switch is fully closed.

The switches are, as a rule, tripped on overload by trip coils acting directly on the switch toggle and operated by bushing type current transformers, although the other methods of tripping oil switches in general use can, of course, be

Fig. 2. Solenoid Operated Oil Switch for 100 Amperes at 130,000 Volts

applied. These transformers consist of the switch stud as the primary and a copper ribbon wound on an iron core around the bushing as the secondary. From one to six transformers with from one to three trip coils may be used on a three-phase circuit, depending on the protection required. The bushing transformer has been designed to furnish at a lost cost a series transformer for high tension systems. It may also be used to furnish current for ammeters where only approximate accuracy is required. These switches have been developed by the General Electric Co., Schenectady, N. Y., and are for use on lines from 22,000 volts upward.

* * *

When the additions and alterations to its huge grain elevator at Kansas City now under way are completed, the Missouri Pacific-Iron Mountain R. R. will have one of the largest plants of its kind in the world. As originally constructed, the elevator consisted of ten concrete circular storage tanks, with a capacity of 80,000 bushels each, or 800,000 bushels in all, and the elevator building proper, with a capacity of 200,000 bushels, a total plant capacity of 1,000,000 bushels. Forty additional concrete circular storage bins, 22 feet in diameter and 84 feet deep, with a capacity of 25,000 bushels each or 1,000,000 bushels all told, are under construction, besides nineteen smaller bins, with a capacity of 7000 bushels each or 133,000 bushels total. The latter are what is known as "interstice" storage bins, and they will occupy the space formerly left vacant between the circular bins of this style of elevator. The elevator will have a total of sixty-nine units of storage space, with a capacity of 2,133,000 bushels, which is more than double its present capacity.

* * *

Interesting sidelights are being thrown upon the results of the great national aeroplane subscriptions inaugurated two years ago, when, as the result of voluntary contributions by citizens, 208 aeroplanes were presented to the French army. It is alleged that certain manufacturers of aeroplanes seized on this opportunity to dispose of machines that were not of the most recent and improved types, and that many of the machines bought for the money collected by the national subscription were not new. The French army has acquired nearly one thousand aeroplanes since the beginning of 1911. The Blériot Works alone have built 181 military aeroplanes and Farman 105. This indicates why the aeroplane industry in France has developed to such an extent as compared with that in other countries.

WHAT TO PATENT

BY CON WISE

This is not an attempt to catalogue the numerous things for which the world is clamoring and which are sure to bring unlimited wealth to the patentee at a moment's notice. It is an attempt to start a discussion as to what inventions it is worth while to protect. The big values are in basic patents skillfully followed up by minor combination patents taken out at such intervals that they practically extend the life of the original patent. As F. W. Harris pointed out in the July number of MACHINERY, it is possible to obtain a patent that has no value except to the holder of the bottom patent or else which makes the bottom patent unworkable. If the holder of one patent won't buy, then the other is worthless, but there are a number of men who have made a comfortable living following up inventions in this way. Hardly any inventor is far-sighted enough to protect himself fully in his original patent and still fewer attorneys are shrewd enough to secure this protection, or it may be that they are just shrewd enough to see the possibility of getting another patent to take out if their client should happen to think of an improvement which he might also protect. For this very reason it is wise to file an application on as broad a ground as possible and then take advantage of the slow procedure of the patent office, to consult as many people as possible as to the working out of your idea.

Suppose, for example, you have invented a one-legged shop stool which maintains its balance by means of a gyroscope under the seat (any one that wishes to borrow this invention is welcome—I haven't money enough to pay the fees). You might as well write up a description, make a drawing yourself and mail the whole thing to the patent office, paying due regard to the rules which they publish, and which are clear enough so that you cannot go far wrong; then put the thing up to people who might buy your stools in some quantity. You will have to do this eventually, so you might as well begin that way. You may find that there is no market for a stool of any kind in a shop unless you create the market yourself. Will your capital hold out while you are making shop superintendents see the value of having men sit at their work? Possibly someone may object to your stool on the ground that their work requires that their men should have a back to lean against, and yours won't stand leaning against. Someone else may sit down and prove to you by mathematics that the seat of your stool will have to be four feet seven and a quarter inches in diameter to cover a gyroscope that will keep it steady, and that it will require a fifty horsepower motor to keep it running, and they won't believe to the contrary even if you bring around a sample to show them. After you have tried to play salesman for about a week you will get a totally different view of what you have invented—that is unless you were entirely crazy about it. You need not fear that anyone will take you up and actually order one of the things. No inventor ever sold anything he invented—he knows too much about it. Wait till you hear some professional salesman sell a hundred of your one-legged milking stools to some rich agriculturist, one for each cow. Then you will realize that inventing and selling are for two entirely different sets of consciences.

But to get back to the subject. It is hardly to be expected that anyone without abundant time and funds at his command will make fundamental inventions in the future with any great frequency. The field is pretty well covered and large concerns are spending large amounts of money trying to do just that. The field for the individual inventor has narrowed down to improvements on already existing devices, which may be sold to the holders of the fundamental patents or which may be worked with small capital. For example, one of my neighbors has recently made a fortune out of a labelling machine. There are and have been for years patents galore on such a machine, but there have been very few machines because those that would work were too expensive and those that were reasonable in price would not label. This man studied the situation and finally bobbed up with a simplification of the complicated machine. He had not really invented a new machine, but none of the old ones were worth anything at all, so he was able to gather in the previous patents for a song and then he came out with a patent that, with the others, made a pretty strong combination. Mind one thing though, he knew the ins and outs of the machines that had been built before, because he had built a number of them. Don't try to invent something that you don't know anything about yourself. You may find that what you are trying so hard to invent has been invented before and used and forgotten. Of course it gives more play to your imagination to get up something about which you know nothing, but it also gives more play to the pocket-book. If your job is chucking pulleys invent a new chucking drill or a chuck or something that you are familiar with; don't start to invent a dish washer—let your wife do that.

Just because you can get a patent allowed is no sign it is worth the paper it is written on. I do not doubt you could get a patent on a dining room chair with a bouquet holder on one side, and your next-door neighbor could probably get one on the same chair with a holder on each side, but what would they be worth, unless it was the fashion to wear flowers that way? And if you get a patent that is good for something it is worth nothing to you unless you can sell it. The place to sell it is where they are taking out patents as a regular thing. They have ten chances to one of anyone else, of being able to use it. It may be that they want to ward off an attack by some competitor, or it may just supplement some more important invention of their own, or it may point a way to them that is worth following up. In any of these cases they would much prefer to put the thing through the office in their own way and at their own expense.

* * *

DENATURED ELECTRICITY

An interesting method of preventing the improper use of electric current has been devised by an Italian engineer. The practice of making especially low rates for current to be used in electric power, heating and cooking devices is becoming more and more general, but with the ordinary constant potential current it is difficult to detect the use of lighting devices on circuits intended only for power and heating purposes. This engineer advocates the use of special circuits on which the current is subject to extreme fluctuation of voltage at rapidly recurring intervals, which would make it practically impossible to use lamps, because of the flicker in the lights. As the current is not entirely interrupted and the normal voltage is almost immediately restored the proper operation of power or heating apparatus is not interfered with and the rightful use of the circuits for their respective purposes is assured.

* * *

Henry J. Gaisman of New York City lately received a check for $300,000 for his invention of means for identifying photographic negatives at the time of exposure. Mr. Gaisman's invention was bought by the Eastman Kodak Co. of Rochester, N. Y. It comprises a window in the back of the camera which when opened exposes a red strip of paper on which a legend can be written with a stylus. The writing makes a break in a strip of chemically-prepared paper underneath, and sufficient light is admitted to print the writing on the negative. Hence when the negative is developed the writing develops also, and it appears on the prints made from the negative. The value of the invention will be apparent to all who have taken any photographs; oftentimes it is difficult to identify the various negatives even if careful memoranda are made of each at the time of making the exposure.

* * *

The three-hundredth anniversary of the invention of logarithms by John Napier is celebrated this year. Napier published in 1614 his work, "Description of the Admirable Canon of Logarithms," in which the statement appeared on the title page that he was the author and inventor, which was the fact, as he was the inventor of the method of logarithmic calculation and of the word logarithm itself. The debt owed to Napier by the scientific world can hardly be overestimated. The advent of logarithms marked an epoch in the history of science. Napier was born in 1550 at Merchiston Castle, near Edinburgh, and died in 1617.

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EXHIBITS AT PANAMA-PACIFIC INTERNATIONAL EXPOSITION

More than sixty thousand exhibits have already been accepted by the division of exhibits of the Panama-Pacific International Exposition and there is every likelihood of this number being increased to eighty thousand before the last of the final allotments of space have been made. The first installation was started on May 27 in the palace of machinery when a 500 H. P. Diesel engine was placed in the center of the building. On the following day five thousand cases of exhibits arrived at the exposition and these are now being placed in their respective positions. It can be safely asserted that the finest collection of electrical and machinery exhibits ever assembled under one roof will be displayed in the palace of machinery. About five thousand exhibits will be shown there. Although the building is 967 feet long and 367 feet wide, the space has been over-applied for.

A feature of the palace's display will be the fact that every operating exhibit—and practically all of them will be in operation—will be equipped with "safety-first" appliances. The exhibitors have also cooperated with the officials in so associating their exhibits with others that complete operation will be possible, and the merits of the various exhibits will be well displayed. Machines will be shown in parts, with cross-sections, and the various workings of the different parts of the interior construction open to the view. The products of the machines shown in the various stages of manufacture, from the raw material to the finished article, will call particular attention to the machine.

Electric current for any use desired will be available to exhibitors in all of the buildings. The charge will be small, based on the actual cost. Steam will be supplied in the palace of machinery from the Gas and Fuel Building which is adjacent. When the product of the machines is turned over to the exposition, the air, steam and electricity will be supplied free. This applies to boilers, engines, compressors, ice machines, gas producers, machine tools, etc., which may be placed as exhibits in the service of the exposition.

Fuel oil will be supplied in part from stills in a model oil exhibit, which will be located in a building east of the palace of machinery and operated by the United States Government. Engine tests will be made on the different grades of refined oil coming from this interesting exhibit which will be open to the public. A large number of manufacturers are arranging to send their expert shop men with the exhibits so that the public may gain a clear idea of the efficient methods by which the finished products are made. The latest types of conveying machinery will be so arranged and the construction and operation so clearly shown that the carrying of small packages, as well as large and bulky boxes on the same conveyor to any height or distance will be as well demonstrated as it would be in a modern and up-to-date factory. Working exhibits of the latest type of hydraulic motors, such as impulse wheels and turbines, with the necessary regulating and control apparatus will be shown connected with pumps and electric generators with the working parts of the wheels and turbines exposed through glass plates.

In the palace of mines and metallurgy will be intensely interesting exhibits of all phases and features of the mining and metallurgical industries. The United States Steel corporation and its subsidiary companies intend having a comprehensive exhibit of its operations and will begin with the ore fields and carry on an educative picture of its operations in ore mining, rail and water transportation, dock operations, coal, coke and pig-iron production, steel manufacturing in its various lines, and will also present the processes of manufacturing of many of its subsidiary companies' products; also how it utilizes its by-products and the display of many of the uses in which its general products are employed, typifying the advancement in uses of this country's resources.

Two hundred and thirty-six national and international organizations have already accepted the invitation of the exposition to hold their 1915 conventions in San Francisco, and many thousand visitors will thus attend as delegates and representatives of these organizations.

VANADIUM STEEL FOR BLOW-PIPE HEADS

An interesting characteristic of chrome-vanadium steel has been demonstrated by tests made on blow-pipes used in glass factories by glass blowers. The pipes used by incandescent lamp manufacturers have been soft steel or Norway iron, inasmuch as they are easy to weld and do not oxidize rapidly. But blow-pipes made of common steel or iron must be frequently repaired, because the hot glass clings to them so tightly that they have to be hammered to remove it, but not so with chrome-vanadium steel. The glass cracks off freely and consequently the repairs on the chrome-vanadium steel pipes are less than on pipes made of iron or machinery steel.

* * *

PERSONALS

Jesse W. Reno of New York was awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute, for his escalator.

E. K. Morgan has been promoted from the position of foreman to superintendent of the Rockford Drilling Machine Co., Rockford, Ill. Mr. Morgan takes the position of John S. Langwill, lately deceased.

F. C. Kent, formerly general superintendent of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., is now connected with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, in the capacity of works manager.

Dudley A. Johnson has been made manager of the Chicago branch of the Joseph Dixon Crucible Co., succeeding the late Sam Mayer. Mr. Johnson was assistant to Mr. Mayer for a number of years and has had extensive experience in the lead pencil and stationery business with other concerns.

Adolph Spielman, inventor of an electrically-driven portable machine for cutting cloth up to 150 thicknesses to any desired pattern at one time, was awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute.

Charles Eisler, for the past two years employed as designer of general tools and special machinery by the United Incandescent Lamp & Electrical Co., Ujpest, Austria-Hungary, and previously as general tool-room foreman with the Metzger Motor Car Co., Detroit, Mich., has taken a position as special machine designer with the Westinghouse Lamp Co., Bloomfield, N. J.

Thomas H. Mirkel, Jr., formerly general manager of the Southwark Foundry & Machine Co., Philadelphia, Pa., and for the past four years vice-president and general manager of the Poole Engineering & Machine Co., Baltimore, Md., joined the Treadwell Engineering Co., Easton, Pa., July 1. Mr. Mirkel will represent the company in Philadelphia and vicinity, and will have offices in the Mutual Life Bldg., Tenth and Chestnut Sts., Philadelphia.

Henry J. Marks, manager of the New York office of the American Engine & Electric Co., has been made sales manager of the company. Mr. Marks is a member of the American Society of Mechanical Engineers, and of other engineering societies, and has had about twenty years active experience in the operation, manufacture, design and sale of steam engines. He will divide his time between the New York office, 90 West St., and the main office of the company at Bound Brook, N. J.

Charles S. Batdorf of New York was awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute, for his coin counting and wrapping machine, which accurately counts and wraps coins of one, five, ten, twenty-five or fifty cent denominations into crimped cartridges containing twenty, twenty-five, forty or fifty coins as desired. The machine handles 350 coins a minute and automatically rejects counterfeit coins.

Albert Pott, sales manager, Baird Machine Co., Bridgeport, Conn., sailed July 15 on the steamship *France* for a two months' trip through Great Britain and France, to visit the company's foreign representatives and to get in touch with foreign trade in general. The company has experienced a revival of its foreign trade in the past few months, and Mr. Pott is making the trip at this time in order to become thoroughly acquainted with any new phases of foreign business, and to provide for its extension.

Albrecht F. Leue, recently purchasing agent of the Triumph Electric Co., Cincinnati, Ohio, resigned June 30 to enter upon the practice of law. Mr. Leue was born in Cincinnati in 1877, and graduated from the University of Cincinnati in

1898. He entered the employ of the Triumph Electric Co. in January, 1900, being engaged successively in the stock, order, correspondence and advertising departments; he has been purchasing agent since April, 1906. He studied law at the Y. M. C. A. night law school, Cincinnati, and was admitted to the Ohio bar in 1905. It is Mr. Leue's intention to give special attention to commercial and corporation law work.

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OBITUARIES

Charles S. Barton, president of the Rice, Barton & Fales Machine & Iron Co., Worcester, Mass., died July 11 of a cancer in the throat, aged fifty-six years.

John S. Langwill, superintendent of the Rockford Drilling Machine Co., Rockford, Ill., died June 22 from cerebral hemorrhage, following an illness of about three months. He is survived by his widow and one child.

Morris G. Loder, sales manager of the Carborundum Co.'s branch store in Cleveland, Ohio, died after a long illness July 9 at his home in Cleveland, aged forty-one years. He was born at Strongsville, Ohio, near Cleveland. For some years he was connected with the purchasing department of the Deering Harvester Co., Chicago, Ill., and entered the employ of the Carborundum Co. as sales manager of the Cleveland branch store in 1902. He is survived by Mrs. Loder, his mother, three brothers and a sister.

COMING EVENTS

September 5-11.—Foundry and machine exhibition, showing machinery, tools, equipment and supplies for the foundry and machine shop, Chicago, Ill. C. E. Hoyt, secretary, Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 15-18.—Twenty-second annual convention of the Traveling Engineers' Association at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Central Car Shops, East Buffalo, N. Y.

September 17-22.—Autumn meeting of the Iron and Steel Institute in Paris, France. Offices of secretary, 28 Victoria St., London, S. W., England.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

Upper Iowa University, Fayette, Iowa. Catalogue 1913-1914.

University of Utah, Salt Lake City, Utah. Catalogue for 1914-1915, and announcements for the School of Arts and Sciences, School of Education, State School of Mines, School of Medicine and School of Law.

National Association of Corporation Schools. Papers, reports and discussions of the first annual convention, Dayton, Ohio, September 16-19, and proceedings of the organizing convention, New York City, June 24, 1913. 438 pages, 6 by 9 inches. Lee Galloway, secretary, New York University, New York City.

Johns Hopkins University, Baltimore, Md. Five lectures by Logan G. McPherson, as follows: "The Economic Transition," "Railway Competition and Combination," "Government Ownership of Railways," "The Valuation of Railways," and "The Service of Accounts and Statistics." 110 pages, 6 by 9 inches.

American Institute of Metals. Transactions of the seventh annual meeting held in Chicago, Ill., October 13-17. Edited by W. M. Corse, secretary. 381 pages, 6 by 9 inches, exclusive of bulletins 20 to 26, containing abstracts of metallurgical patents, notes and reports during 1913, together with a list of members. Published by the American Institute of Metals, Buffalo, N. Y. W. M. Corse, secretary and treasurer, 106 Morris Ave.

NEW BOOKS AND PAMPHLETS

Report of the Commissioner of Education for the Year Ending June 30, 1913. Volume I. 931 pages, 6 by 9 inches. Published by the United States Bureau of Education, Washington, D. C.

Acoustics of Auditoriums. By F. R. Watson. 34 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin 73.

International Conference of Mine-experiment Stations. By George S. Rice, 99 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 82.

Lumbering Industry of the Philippines. By John R. Arnold. 22 pages, 6 by 9 inches. Published by the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C., as Special Agents Series, No. 88.

The Effect of Titanium on the Magnetic Properties of Iron. By Kenneth P. Applegate. 19 pages, 6 by 9 inches. Published by the Department of Electrical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., Engineering and Science Series, Bulletin 5.

Relative Effects of Carbon Monoxide on Small Animals. By George A. Burrell, Frank M. Seibert and I. W. Robertson. 23 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 62.

Investigations on Drain Tile. 112 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin 36, authorized by the American Society for Testing Materials.

Effect of an Iron Core on the Secondary Currents of a Telephone Transformer. By Eugene C. Helwig. Published by the Department of Electrical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., as Engineering and Science Series Bulletin 6.

The Electrical Resistance and Temperature Coefficient of Copper-Nickel-Manganese Alloys. By George L. Gray. 26 pages, 6 by 9 inches. Published by the Department of Electrical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., as Engineering and Science Series Bulletin 4.

Metric-English and English-Metric Lengths. By G. A. Rosetti. 80 pages, 3½ by 4 inches. Published by E. & F. N. Spon, London, and Spon & Chamberlain, New York City. Price, 40 cents.

This useful work gives equivalents in millimeters (to five significant figures) of English lengths from 1/64 inch to 10 feet, advancing by 1/64 inch; and equivalents to the nearest 1/64 inch of all metric lengths from 1 to 3200 millimeters, advancing by millimeters.

The Tractive Resistance of a Twenty-eight-ton Electric Car. By Harold H. Dunn. 53 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 74.

The bulletin records the results of tests made with a twenty-eight-ton electric car of the double-end type for the purpose of determining the resistance offered to its motion when running on straight level track in still air at uniform speed, and to ascertain the relation existing between that resistance and the speed of the car.

Location of Motorcycle Power Plant Troubles Made Easy. Chart arranged by Victor W. Page. Size, 31 by 22 inches. Published by Norman W. Henley & Son, New York City. Price, 25 cents.

This chart contains a sectional view of the power plant of a motorcycle, the name of each part being plainly indicated. The descriptive part of the chart contains a list of the common derangements that interfere with the proper action of the engine and auxiliary systems, enabling the user to discover quickly the trouble under different conditions.

Link Motion, Valve Gears and Valve Setting. By Fred H. Colvin. 101 pages, 4 by 6 inches. 45 illustrations. Published by Norman W. Henley & Son, New York City. Price, 50 cents.

This practical work on locomotive valve motion was first published in 1905, and the present edition is the third enlarged and revised. Contents by chapter heads are Locomotive Link Motion; Valve Movements; Setting Slide Valves; Analysis by Diagrams; Modern Practice; Slip of Link Block; Slide Valves; Piston Valves; Setting Piston Valves; Other Valve Gears (comprising Joy-Allen, Gooch, Allfree-Hubbell, Walschaerts, Baker, and Southern).

Fitchburg Plan of Cooperative Industrial Education. By Matthew R. McCann. 28 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Education, Washington, D. C., as Bulletin 1913, No. 50.

The bulletin describes the successful high school cooperative course begun in Fitchburg, Mass., in 1908, in which high school students work in the shops one week and go to high school the following week, alternating with another student so that the places in the shop and the school are constantly filled. This method has proved so successful that it has been widely noticed and is known generally as the "Fitchburg plan."

Methods of Oil Recovery in California. By Ralph Arnold and V. R. Garfias. 57 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 70, Petroleum Technology 16.

The report was published by the Bureau of Mines, as one of a series describing the investigations conducted by the bureau in an effort to minimize waste in the production of petroleum from lands belonging to or controlled by the United States government. It treats of the factors controlling production, recoverable oil, oil pumping, plunger pumps, air lifts, bailing, swabbing, tunneling, generation and distribution of power, including steam engines, gas engines, electric motors and windmills.

Mechanical Movements, Devices and Appliances. By Gardner D. Hiscox. 409 pages, 6 by 9 inches. Published by Norman W. Henley & Son, New York City. Price $2.50.

This treatise, describing mechanical movements and devices used in machinery, which is practically a mechanical dictionary, was first published in 1899. It has been well received and the present edition is the fourteenth enlarged. The scope of the work is indicated from the fact that 1890 movements are illustrated and briefly described under the following heads: The Mechanical Powers, Transmission of Power, Measurement of Power, Steam Power, Steam Appliances, Motive Power, Hydraulic Power and Devices, Air Power Appliances, Electric Power and Construction, Navigation and Roads, Gearing, Motion and Devices Controlling Motion, Horological, Mining, Mill and Factory Appliances, Construction and Devices, Drafting Devices, Miscellaneous Devices.

Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo. By Trygve D. Yensen. 73 pages, 6 by 9 inches. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 72.

The efficiency of electrical machinery depends largely upon the magnetic quality of the iron used in the pole pieces and armatures. Many investigations have been conducted with a view to decreasing the hysteresis and eddy current losses of iron and to increase its permeability. The bulletin records the results obtained by melting electrolytically refined iron in a vacuum furnace. It is possible by this means to obtain iron with a carbon content of 0.01 per cent or less without oxidation of the iron. The maximum permeability of this iron at ordinary temperatures is shown to be 19,000, occurring at a flux density of 9500 gausses. The hysteresis loss is from one-half to one-third of that for the best transformer steel used at the present time.

Methods of Machine Shop Work. By Frederick A. Halsey. 286 pages, 6 by 9 inches. 285 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.50.

This interesting and valuable book contains the substance of a number of lectures delivered by the author before the students in mechanical engineering at Columbia University during the past three years. These lectures were published in the belief that they would prove useful elsewhere in the trade as well as in engineering schools and to apprentices. The volume presupposes a fair knowledge of the common machine tools and their general construction, use and application, such as an apprentice would have acquired during one or, at most, two years' work in a modern machine shop. The chapters are headed as follows: Two Systems of Machine Production; Precision Work and Workmanship; Measures of Length; Measurement of Errors; Gages, Fits and Limits; Driving Systems for Machine Tools; Turning and Boring; Floorplate Work; Drilling; Milling; Gear Cutting and Grinding. The book gives a good general idea of the most important machine shop methods and operations. It is to be regretted that ten pages of Chapter III are devoted to an attack on the metric system, a digression hardly warranted in a work of this kind.

Motorcycles, Side Cars and Cycle Cars. By Victor W. Page. 550 pages, 5 by 7¼ inches. 350 illustrations. Published by Norman W. Henley & Son, New York City. Price, $1.50.

This book deals with the construction, management and repair of motorcycles and cycle cars. The subject is handled as far as possible in a non-technical manner, and while some technical information and data are given, the material for the most part is of a practical nature and should be readily assimilated and understood by anyone. The instructions given for the control, maintenance and repair of the machines dealt with should be valuable to any user of motorcycles or cycle cars, and the discussions of mechanical principles will appeal to a still wider circle of readers, including dealers and those connected with the trade in various capacities. An effort has been made to discuss the salient points of representative domestic and foreign makes and to show clearly the mechanical points and distinctive features of each. The book is divided into eight chapters, headed as follows: Motor Cycle Development and Design; Motor Cycle Power Plant Group; Construction and Design of Engine Parts; Lubrication, Carburetion and Ignition; Power Transmission System Parts; Design and Construction of Frame Parts; Constructional Features of Cycle Cars; Motorcycle Maintenance, Operation and Repair.

Brass-Furnace Practice in the United States. By H. W. Gillett. 298 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 73, Mineral Technology 14.

The bulletin records the investigations made by the Bureau of Mines, with a view of eliminating waste in America's miscellaneous mineral industries. There are in America about 3600 plants melting brass and bronze, and 1000 of these melt

nonferrous alloys exclusively. It was shown that in the melting of nonferrous alloys 90 to 95 per cent of the heat units in the fuel do no useful work. On the basis of $120,000,000 being the value of the metal melted each year a 2½ per cent melting loss, equivalent to 5 per cent loss on metal bought means an annual loss of $3,000,000 in metal alone. Reducing the average metal loss to that of the present best practice would mean a saving of over $1,500,000 a year. The bulletin treats of the magnitude of the brass industry; the general types of furnaces in use; describes pit furnaces; natural-draft, pit, coke or coal furnaces; forced-draft coke or coal pit furnaces; oil or gas pit furnaces with burners; tilting furnaces; tilting forced-draft coke furnaces; tilting oil furnaces; open-flame tilting furnaces; reverberatory furnaces; cupola furnaces; and semiproducer furnaces. Possible improvements in furnaces and accessories are discussed. The causes of disease and danger, and essentials for health and safety are also dwelt upon, forming an important and valuable conclusion to the work.

Spur and Bevel Gearing. 306 pages, 6 by 9 inches. 142 engravings. Published by the Industrial Press, New York City. Price, $2.50.

During the past six years MACHINERY has published over 125 25-cent reference books. These well-known books include the best of the material that appeared in MACHINERY during the past years. Many subjects, however, cannot be adequately covered in all their phases in books of this size, and in order to meet the demand for more comprehensive and detailed treatments on the more important mechanical subjects, it has been deemed advisable to bring out a number of larger volumes, each covering one subject completely. The book under review is one of these volumes. In bringing out this book the first consideration was to make its contents meet the practical needs of the machine building trade. Mere theory and academic discussions have been avoided. The rules, formulas and instructions are illustrated whenever practicable, and examples are given to show applications to everyday problems. Theoretical considerations, however, have not been neglected in cases where they are necessary to fully explain a practical process. Hence, this book on spur and bevel gearing is a treatise on both the practice and the theory along such lines as will make it especially useful to practical men. The book contains fifteen chapters headed as follows: Principles and Dimensions of Spur Gearing; Materials used for Gears; Strength and Durability of Spur Gearing; Simplified Formulas for Strength of Gears; The Stub-tooth Gear; Noisy Gearing; The Design of Spur Gearing; Methods of Cutting Spur Gear Teeth; Production and Heat-treatment of Gears; Bevel Gear Rules and Formulas; Strength and Design of Bevel Gears; Methods for Forming the Teeth of Bevel Gears; Milling the Teeth in Bevel Gears; Long and Short Addendum Gears; Skew Bevel Gears.

NEW CATALOGUES AND CIRCULARS

Cutler-Hammer Clutch Co., Milwaukee, Wis. Bulletin 15020 on magnetic couplings, clutches and brakes for rubber mill service.

James Clark, Jr., Electric Co., 520 W. Main St., Louisville, Ky. Leaflet showing "Willey" direct- and alternating-current sensitive drills.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue S of "Brownhoist" suspended concrete bins for coal, ashes, ore and other materials.

William Gaertner & Co., 5345-5349 Lake Park Ave. Chicago, Ill. Catalogue of universal laboratory supports, balances, weights, glassware and supplies.

J. Davidoff, 563 Forty-eighth St., Brooklyn, N. Y. Circular of the Davidoff automatic driving belt, clutch and cam protector for preventing accidents on type-setting machines.

Yale & Towne Mfg. Co., Stamford, Conn. Pamphlet entitled "Safety First" illustrating and describing a simple device for the prevention of accidents on power presses.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Leaflet treating of the operating principle of S. K. F. ball bearings and the advantages to be secured through their use.

Marvin & Casler Co., Canastota, N. Y. Leaflet descriptive of rotary center indicator, an instrument designed to indicate quickly and accurately the center or axis of a rotating spindle or shaft.

Kasenit Ltd., 8-9 Ludgate Square, Ludgate Hill, London, England. Circular of the Keen impact ball tester described in the July, 1913, number of MACHINERY. Kasenit Ltd. is marketing the tester abroad.

Newark Gear Cutting Machine Co., 67 Prospect St., Newark, N. J. Leaflet advertising "Newark" gears. This company makes gears of all kinds of the highest degree of precision, for heavy duty and for ordinary work.

Warner & Swasey Co., Cleveland, Ohio. Catalogue of No. 4 universal turret screw machine for manufacturing duplicate parts from bar stock, castings and forgings. The machine is provided with power traverse for both carriage and turret simultaneously.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 4 discusses the importance of large die opening and shows how this effects economy in the forging machine. National heavy-pattern forging machines are made with four-five- and six-inch die openings.

F. W. King Optical Co., Euclid Arcade, Cleveland, Ohio. Circular of the "I-Safe" goggle for workers in steel works, foundries, machine shops and wherever eyesight is endangered by flying particles; also of colored glasses for electric arc and oxy-acetylene welding operators, etc.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-N, describing class "N" "Chicago Pneumatic" steam and power driven enclosed compressors. Simplicity, rigidity, exceptionally large bearing surfaces, automatic lubrication and indestructible flat disk valves are the salient features of this type of compressors.

Stow Mfg. Co., Binghamton, N. Y. Catalogue 14, 96 pages, 6 by 9 inches, describing the general line of portable tools of this company's manufacture, including flexible shafts, drill presses, tapping and reaming machines, grinders, motors and electric drills, boring machines, etc. The company also makes motors and grinders of the stationary type.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48901, describing the construction and giving dimensions of electric winches and winding drums. These machines are designed for use on work for which the ordinary overhead hoist is not adapted. The application for hauling cars, locomotives in repair shops, and heavy trucks up inclines at ferries, is illustrated.

Joseph T. Ryerson & Son, Chicago, Ill. Bulletins 9071 and 13071, illustrative of the Ryerson high-speed friction saw and the Lennox serpentine shear, respectively. Books Nos. 4 and 8 of the Technical Library Series, treating of internal furnace boilers with Morison corrugated furnaces, and concrete reinforcing, respectively. The last book shows steel bars, expanded metal and corrugated sheet steel centering used in reinforcing concrete.

Allen-Bradley Co., Milwaukee, Wis. Bulletin B-571 illustrating type CR speed regulators for reducing the speed of two- and three-phase slip ring motors and containing tables of dimensions and prices. The features claimed for this device are compactness, overload capacity, and infinite speed adjustment between minimum and full speed of motor, regardless of load. The company will gladly furnish additional details to those interested.

Cleveland Twist Drill Co., Cleveland, Ohio, has issued a special anniversary number of its monthly house organ "Drill Chips" which contains an interesting description of the making of a twist drill, from the inspection of the bar stock in the laboratories to the testing of the finished product. The booklet is illustrated with views taken in the plant of the Cleveland Twist Drill Co., and the information contained is of considerable general interest.

Colburn Machine Tool Co., Franklin, Pa. Bulletins 68, 69, and 71, illustrating and describing Colburn vertical boring and turning mills of 42, 48, and 60-inch capacities, respectively. Bulletins 55, 67 and 70, treating of special attachments for Colburn boring mills including pulley crowning attachment, faceplate jaws and chucks, adjusting and safety devices, etc. Bulletins 53, 62, and 64 on Colburn D-5 heavy-duty drill press of 36-inch swing and attachments.

Tate-Jones & Co., Inc., Pittsburg, Pa. Catalogue on heat-treating furnaces, telling of the uses, features of construction and points of advantage of Tate-Jones annealing, packhardening, casehardening, general hardening, muffle, lead hardening, crucible oil-tempering and other furnaces. The various types of furnaces are illustrated and tables giving stock sizes of each are included. The book is an attractive publication, illustrated with good half-tones and tastefully arranged.

Halcomb Steel Co., Syracuse, N. Y. Booklet on "Ketos" tool steel, containing 49 pages, 4¼ by 8 inches. "Ketos" steel is of especial value for use in intricate tools where the labor cost greatly exceeds the cost of the steel. The features claimed for it are durability, keen cutting power, and non-shrinkage and non-warping properties. The book is illustrated with views showing a number of intricate tools made from "Ketos" steel without distortion, warping or cracking troubles.

Link-Belt Co., Chicago, Ill. Section A of catalogue 110 on Ewart detachable link-belt and sprocket wheels, containing complete information on detachable link-belt and illustrated with halftones made from unretouched photographs of chain links, full size. Rules for obtaining the working strains and horsepower of link-belts are given, and directions for determining the position of link-belt on sprockets showing whether the hook or the bar of the chain should run first. Users of link-belt will find this sectional catalogue a valuable instruction book.

Colonial Steel Co., Pittsburg, Pa. Catalogue 13 descriptive of the process of manufacturing Colonial tool steel. 49 pages, 5 by 7 inches, printed in colors. The method of manufacturing tool steel is described step by step, and the illustrations show the iron being melted in the crucible furnace, drawing the ball, drawing off the slag, packing the crucibles, casting the metal into molds, stripping ingots from molds, hammering, and inspection. Information is also given on annealing, hardening and tempering carbon steels, and selecting tool steel.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Booklet outlining the company's plan of pensioning employes and its life insurance and vacation allowance systems. A fund is set aside by the company for payments on account of the pension, life insurance and vacation systems. Any employe who has reached the age of 65 and has been for twenty-five years continuously in the employ of the company may be retired on a pension. Employes may also be retired at 55 at the option of the company. Special provision is made for those engaged in hard physical service in the forge, blacksmith and polishing departments. All employes who have worked continuously for three or more years for the company are entitled to have insurance paid to their beneficiaries in case of death. Employes who have worked two or more years for the company are given one-half week's pay as a vacation allowance and those who have been five or more years with the company are allowed one week's pay.

Kearney & Trecker Co., Milwaukee, Wis. Catalogue on "Milwaukee" milling machines, 86 pages, 6 by 9 inches. This book contains a complete description of the line of milling machines and their various parts and attachments manufactured by this company. The "Milwaukee" milling machines are made in both horizontal and vertical types. A special feature of the horizontal type is the double over-arm which provides exceptional rigidity to the cutter and insures positive alignment of the arbors. The cascade system of lubrication is also an exclusive feature of the "Milwaukee" milling machines. The lubricant is stored in a reservoir at the bottom of the machine, and pumped to the top, from where it "cascades" down over all gears and bearings, providing a continuous system of lubrication. There is a separate lubricating system for the cutter, which operates only when the spindle is rotating. Special safety provisions have been made, all gears, belts, pulleys, etc., being carefully guarded.

R. K. Le Blond Machine Tool Co., Cincinnati, Ohio, has brought out a treatise on Le Blond milling machines, and milling practice. This book contains 220 pages, 6 by 9 inches, and sells at 50 cents per copy. It contains information on kinds of milling, feeds and speeds, cutter design, milling machine construction, care and adjustments of milling machines, dividing heads and systems of indexing, spiral cutting, and data on bevel, worm and spur gearing. The section on milling practice shows a variety of interesting examples of milling, including slab and face milling, form milling, surface milling, straddle milling and a great many special jobs. A number of tables giving the equivalents of millimeters in inches and inches in millimeters, Morse tapers, cutting speeds, decimal equivalents, angles for fluting spiral milling cutters, sines and cosines, tangents and cotangents, etc., are included. The table of leads obtainable with the change gears furnished with Le Blond spiral cutting head covers twenty-nine pages. This book should be of great value to all engaged in milling machine practice, and practically indispensable to those using Le Blond milling machines.

TRADE NOTES

Bosch Magneto Co., 223 W. 42nd St., New York City, has taken over the Rushmore Dynamo Works of Plainfield, N. J., which will be operated in conjunction with the company's factory in Springfield, Mass., in the manufacture of Bosch lighting and starting systems.

Adams-Campbell Co., Los Angeles, Cal., has just completed a modern factory building at 1730-1734 S. Los Angeles St., and will install additional equipment in shop, foundry and plating plant, for the manufacture of brass goods, sheet metal and wire novelties, for tool and die making and general machine work.

National Business Bureau, Fourteenth St. and Pennsylvania Ave., Washington, D. C., offers its services to corporations and various business interests in matters affecting trade conditions and business relations. The bureau advises its subscribers of all legislation, past, present and pending, affecting tariff, banking currency, income tax, etc.

Clipper Belt Lacer Co., 1020 Front Ave., Grand Rapids, Mich., shipped a carload of No. 2 "Clipper" lacers and hooks to its European agents, Schuchardt & Schutte, Berlin, Germany, the latter part of June. This was the company's first shipment abroad, and was placed through the efforts of W. K. Lee, who is spending some time in Europe in the company's interest.

Michigan Electric Welding Co., 514 Hart Ave., Detroit, Mich., has completed an addition of 4017 square feet area, making the total increase of floor area within the year 8070 square feet. Equipment has been added which increases the scope of the work. The company manufactures automobile parts and does butt and spot job welding. Drag links and brake rod assemblies are its specialties.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y., has organized a bronze department for the manufacture of titanium-bronze specialties under its various patents. William M. Corse, formerly works manager of the Lumen Bearing Co. of Buffalo, and lately general manager of the Empire Smelting Co., Depew, N. Y., will be associated with the company as manager of this new department.

Butterfield & Co., Derby Lane, Vt., and Rock Island, Quebec, are building an addition to their factory at Rock Island. The building will be 185 feet long, 60 feet wide and three stories high, and will be constructed of brick and concrete. A portion of the new structure will be used for manufacturing twist drills and milling cutters; it is hoped that the new factory will be in operation January 1, 1915.

H. A. Strauss Data-Card Service, Harris Trust Bldg., Chicago, Ill., has begun the publication of technical data cards 5 by 8 inches, which are intended to cover the entire field of engineering and the allied trades and sciences. The copy for the cards is done in India ink, free-hand. The cards are printed from zinc etchings reduced to the required size, and the data is thus presented in a very compact but readable style.

THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

MACHINERY

PUBLICATION OFFICES 140-148 LAFAYETTE STREET, CORNER HOWARD, NEW YORK

VOL. 20. NO. 12
ENGINEERING EDITION

AUGUST, 1914

$2.00 A YEAR
20 CENTS A COPY

ADVERTISERS INDEX, PAGE 230—PRODUCT INDEX, 216-228

ENGINEERING EDITION

84 PAGES
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PUBLISHED BY THE INDUSTRIAL PRESS
140-148 LAFAYETTE ST., NEW YORK CITY

SHOP EDITION

56 PAGES
$1.00 A YEAR

VOL. 20 — NO. 12

CONTENTS FOR AUGUST 1914

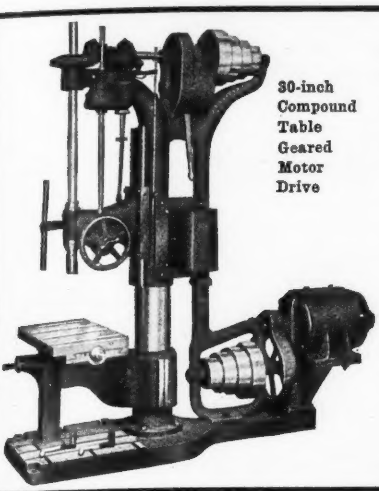
Classifying the Reader

One of the most interesting things about human beings is their variety. The moment you attempt to classify them specifically you find that your labels don't fit. Take the reader of MACHINERY for example. Each advertiser has a label in his mind, more or less definitely outlined, which, from his viewpoint, fits the average reader. We have no doubt that in general terms it does fit, but we know that the labels themselves differ, especially in the effort to define the habits and viewpoints of readers.

It is our business to know definitely not only *who* MACHINERY'S readers are, and *where* they are, but *what* they are. By which we mean that we must know their business and occupation as well as their name and address. In most cases we know who they are and their business or occupation long before they subscribe, because it is of the utmost importance for us to know it. The names of more than 90 per cent of new subscribers for MACHINERY *come out of our own working lists*, which is , we think, definite enough.

MACHINERY'S working lists are in two divisions. One division, comprising only principals and mechanical executives, contains nearly 65,000 names. The other, with nearly 180,000 names, is a list of designers, toolmakers, machinists and others variously occupied in the mechanical field. From the names in this list, MACHINERY'S mail-order work constantly segregates the intelligent, ambitious and progressive. Our readers are necessarily the brightest minds in the metal-working industries. The others neither read nor study and MACHINERY is not for them any more than Shakespeare is.

The labels which form unconsciously in the minds of our 470 advertisers agree in classifying the reader as a man engaged in mechanical work—proprietor, works manager, chief designer, master mechanic, foreman, head machinist, or by whatever titles the responsible men are designated. They differ only in trying to classify the reader rigidly as to his habit of reading advertising. Some read all the advertising regularly, but a great many, having familiarized themselves at one time or another with the tools advertised, read only the new points developed; while the busiest men in the field aim only to keep posted on the latest tools and practice and use the journal as a directory of the trade. No label fits them all. But the facts emphasize the vital importance to the advertiser of keeping his advertising always up to the highest standards, keeping it fresh and interesting and putting definite information into it.



30-inch Compound Table Geared Motor Drive

SNYDER DRILLS

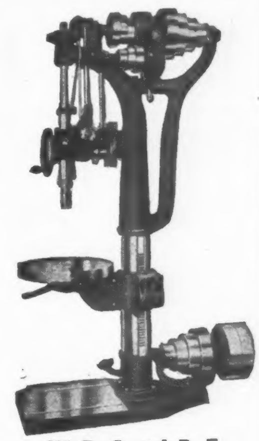
None better, and few equal. Accurate in Construction, Rigid in Operation, Great Time Savers in Production. They have met the demands for all purposes, at all times, in all countries for the past thirty years. We have sold thousands of them, and none have been returned. On these statements our reputation, established for thirty years, is based.

MANNING, MAXWELL & MOORE, Inc., Selling Agents

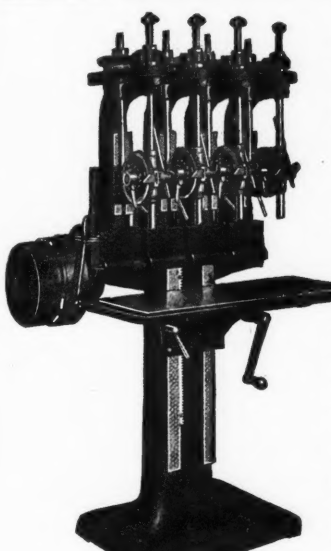
J. E. SNYDER & SON

WORCESTER, MASS.

Sizes 20", 21", 23", 25", 28", 30", 36" and 46"



23" B. G. and P. F.



Small Drills in Multiple

For drilling small holes, working fast and holding its accuracy, the Taylor & Fenn manufacturing Multiple Spindle Drilling Machine cannot be surpassed. It affords the right speed and the right feed for drilling up to ¾" diameter, and a ½" hole one inch deep can be drilled in cast iron in four seconds. A series of gears and silent chains have proven much better and more efficient than belts for driving a machine of this type—they will not slip, there is less friction, and speed changes are more readily made.

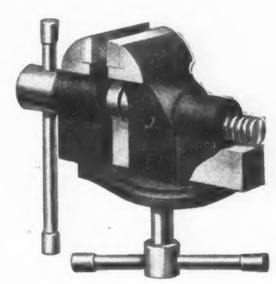
Send for specifications—ask for catalogue.

THE TAYLOR & FENN COMPANY

HARTFORD, CONN.

EUROPEAN AGENTS: E. Sonnenthal, Jr., Berlin, Cologne and Vienna. R. S. Stokvis & Zonen, Ltd., Rotterdam and Brussels. Alfred H. Schutte, Paris, Milan and Barcelona. Schuchardt & Schutte, Stockholm, Copenhagen and St. Petersburg. C. W. Burton, Griffiths & Co., London.

WALWORTH MAKES THEM



THE OLD RELIABLE WALWORTH VISE

Walworth Mfg. Co.

BOSTON, U. S. A.

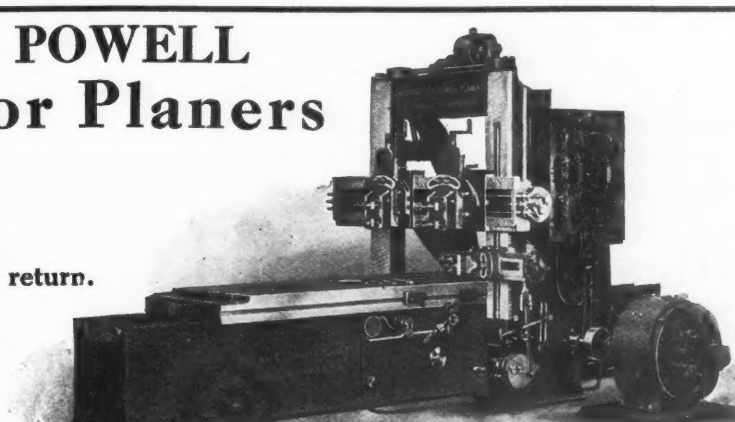
NEW YORK 42 Broadway

CHICAGO 15-21 So. Desplaines St.

WOODWARD & POWELL
Reversing Motor Planers

ADVANTAGES

Elimination of belt slippage,
Increased output with less power,
Variable speeds on both cut and return.



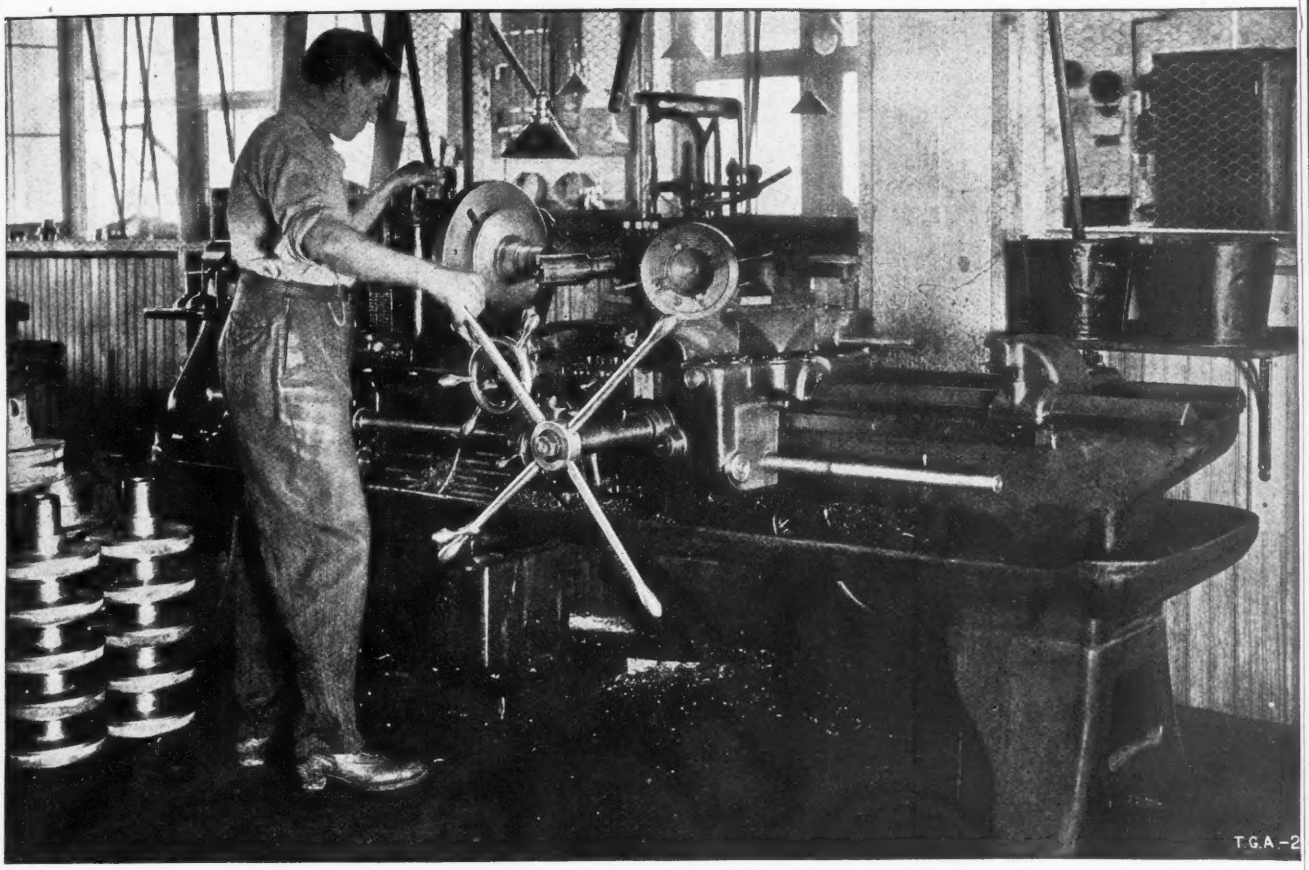
Woodward & Powell Planer Co.

WORCESTER, MASS., U. S. A.

AGENTS: Manning, Maxwell & Moore, Inc., New York, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Milwaukee, Philadelphia, Pittsburgh, St. Louis, San Francisco. Alexander & Garsed, Charlotte, N. C. The Allied Machinery Co. of America, Paris, France; Brussels, Belgium.

Production Figures Furnished

Send Samples or Drawings



Pratt & Whitney Turntable Lathe

Showing second operation on an axle part

High Production

In the first place, the Turntable Lathe has ample weight and liberal bearing surfaces; in fact, its design throughout is such as to afford unquestioned stability. Secondly, in points of strength, the gearing, shafting, etc., are designed with ample factor of safety to transmit all the power the best high-speed steel can use. Therefore cuts, feeds and speeds are not limited by the machine.

The next requirement for high production is ease and convenience of operation, which has been very carefully worked out. Six feeds and eight speeds with a range covering all requirements are instantly available by levers within easy reach of operator while watching the work. Speeds can be changed while machine is running. The nine carriage stops are located on front of machine and are easily set for duplicate work. Stops are positive, insuring accuracy.

Accuracy

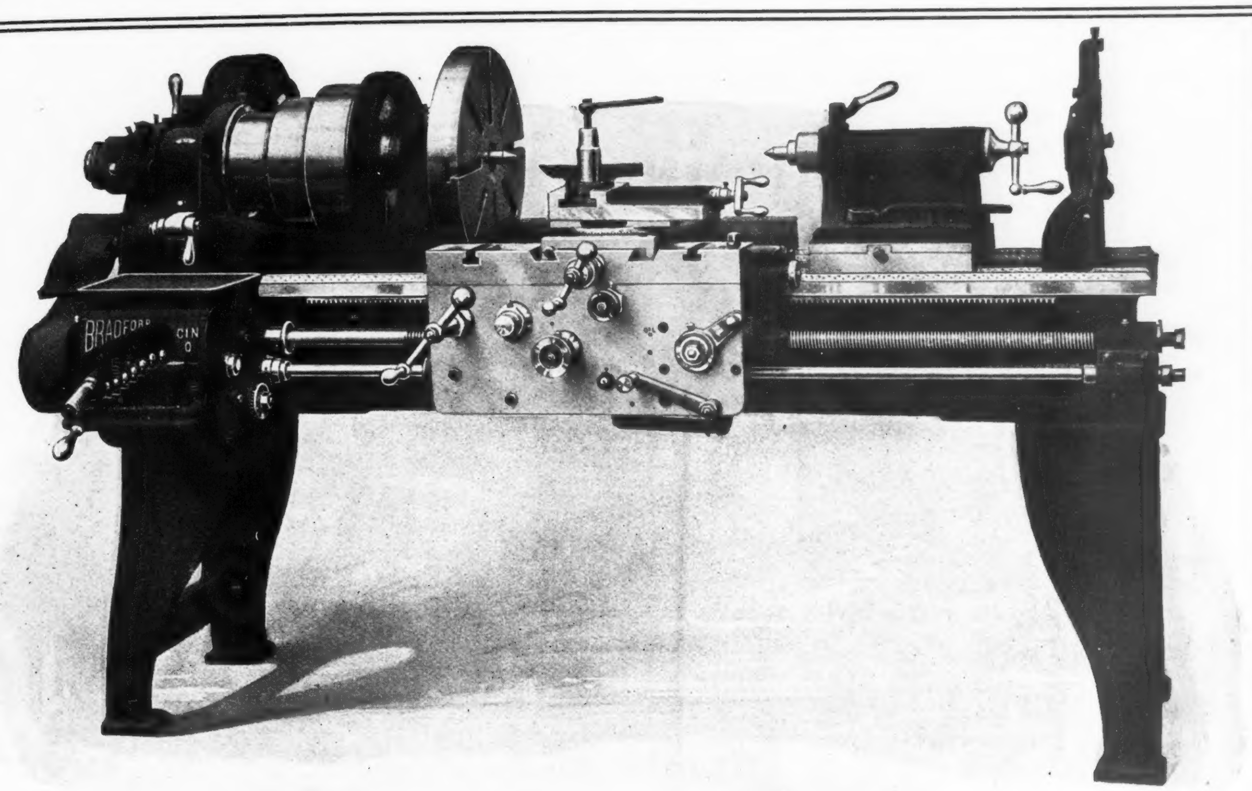
Ample weight, proper design for utmost rigidity, liberal bearing surfaces and careful workmanship, combine to make the Turntable Lathe the most accurate tool of its type. Perhaps the most important reason for the rigidity and accuracy of this lathe is the cross sliding turret, the headstock being bolted solidly to the bed. Thus the tool is given absolutely rigid support for any cut.

The mounting of the cross slide upon the carriage with liberal bearing surface and a dovetail narrow guide with taper gib, assures the necessary stability and continued accuracy. The Turntable is rigidly bound to the slide by a very efficient binder located directly under the tool in operation.

Send drawings or samples. We shall be pleased to give you production figures.

PRATT & WHITNEY CO., Hartford, Conn.

SALES OFFICES AND AGENCIES: New York: 111 Broadway. **Boston:** 93-95 Oliver St. **Philadelphia:** 405 North 21st St. **Pittsburgh, Pa.:** Frick Bldg. **Cleveland:** Rockefeller Bldg. **Cincinnati:** 336 West 4th St. **Detroit:** Majestic Bldg. **Chicago:** 12 North Jefferson St. **St. Louis:** 516 North Third St. **Agent for Gulf States:** N. C. Walpole, 2015 First Ave., Birmingham, Ala. **For Colorado:** Hendrie & Bolthoff Mfg. & Supply Co., Denver. **For California, Nevada and Arizona:** Harron, Rickard & McCone, San Francisco and Los Angeles. **For Washington and Idaho:** Hallidie Machinery Co., Seattle and Spokane. **For Oregon:** Portland Machinery Co., Portland. **Agents for Canada:** The Canadian Fairbanks-Morse Co., Ltd., Montreal, St. John, Toronto, Winnipeg, Calgary and Vancouver. **London, E. C.:** Buck & Hickman, Ltd., 2 and 4 Whitechapel Road. **London, S. W.:** Niles-Bement-Pond Co., 25 Victoria St. **Birmingham, Eng.:** Buck & Hickman, Ltd. **France, Belgium, Switzerland and Colonies:** R. S. Stokvis & Fils, 103 Rue Lafayette, Paris. **Japan:** The F. W. Horne Co., 6 Takiyama-cho, Kyobashi-ku, Tokio. **Italy:** Ing. Ercole Vaghi, Milan. **Germany:** F. G. Kretschmer & Co., Frankfurt, a/M. **Austria-Hungary:** E. Krause & Co., Vienna, Prague and Budapest. **Holland:** R. S. Stokvis & Zonen, Ltd., Rotterdam. **Mexico:** The Railway Supply Co., S. A., Cinco de Mayo, 6, Mexico City. **Russia:** S. G. Martin & Co., Ltd., St. Petersburg and Moscow. **Brazil:** Comptoir Technique Bresilien, P. O. Box 802, Rio de Janeiro.



THE "BRADFORD"

A SERVICE LATHE

The Bradford Machine Tool Company

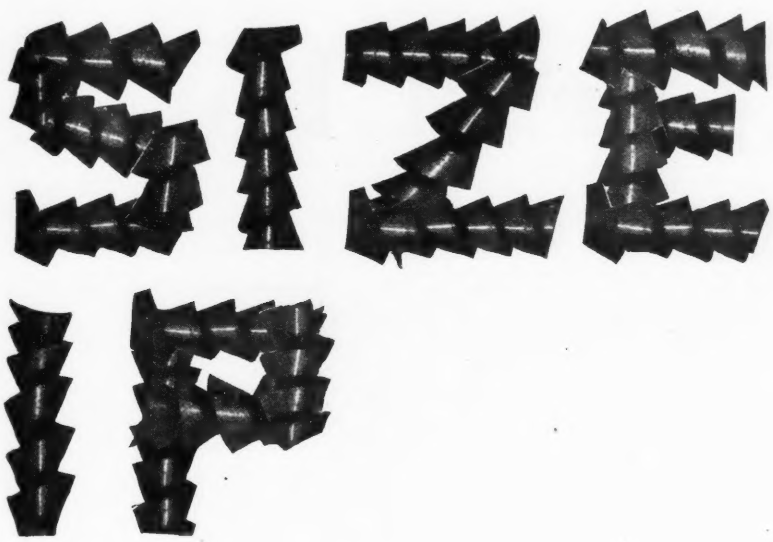
Cincinnati, Ohio, U.S.A.

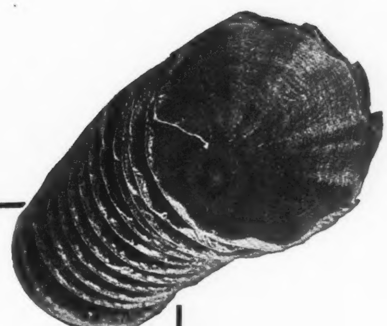
AGENTS: Swind Machinery Co., Philadelphia. Hill, Clarke & Co., New York. Taylor Machinery Co., Boston, Mass. The H. A. Stocker Machinery Co., Chicago, Ill. Marshall & Huschart Machinery Co., St. Louis, Mo. Somers, Fitler & Todd Co., Pittsburgh, Pa. E. A. Kinsey Co., Cincinnati, O., and Indianapolis, Ind. The Mine & Smelter Supply Co., Denver, Colo. Pacific Tool & Supply Co., San Francisco, Cal. The F. W. Horne Co., Tokio, Agent for Japan, China and the Far East. Chas. Churchill & Co., Ltd., London, Birmingham, Glasgow, Newcastle-on-Tyne. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Agents for Germany, Belgium, France, Spain, Portugal, Italy, Sweden, Norway and Russia. Alfred H. Schutte, Koln-Deutz and its branches in Berlin W. 87, Brussels, Paris, Barcelona, Bilbao, Milan and St. Petersburg.

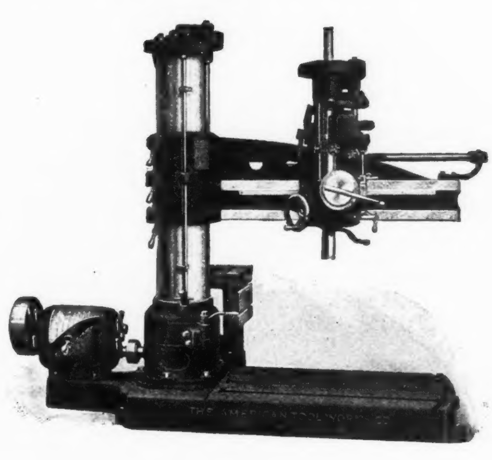
WHAT *service* can I expect from your machine? This is the natural question of a buyer, and whatever else the machine may have—simplicity of design, solid construction, easy manipulation or other advantages—the one great, all combining feature must be maximum production and durability—in other words—*service.*

Bradford Lathes render exceptional service in many ways. They have large capacity, but are compact enough for small space; they are equipped with quick-change gears, friction double back gears, heavy bed, improved apron and compound rest; bearings are liberal and range of feeds and threads the widest. A special spindle construction permits use of draw bars and tubes for draw-in attachments without change of spindle.

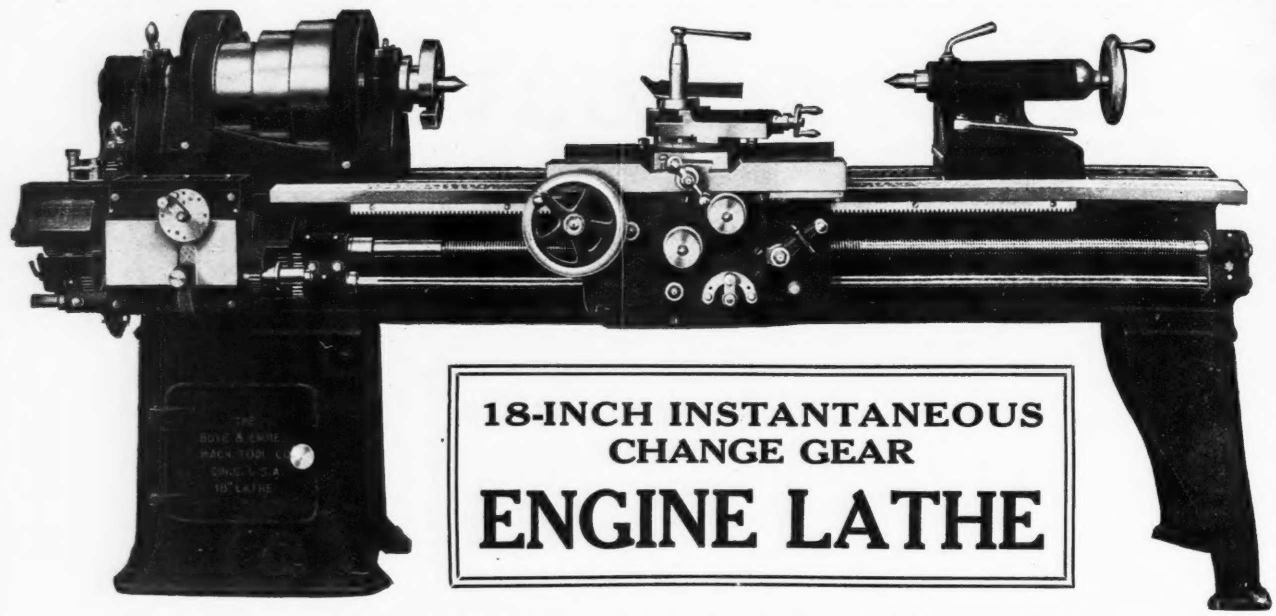
Bradford Lathes are built in sizes from 14-inch to 42-inch swing. New catalog on request.


SIZE





THE BOYE & EMMES MACHINE TOOL CO.



18-INCH INSTANTANEOUS CHANGE GEAR

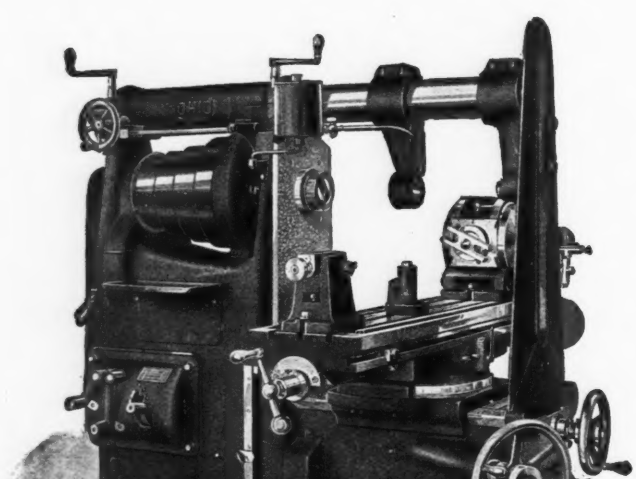
ENGINE LATHE

THREE-STEP CONE, DOUBLE BACK GEAR, permitting of a wide belt at a high velocity for high cutting speeds. DOUBLE PLATE APRON preventing all overhang and straining of studs and pinions. INSTANTANEOUS CHANGE GEAR DEVICE, all changes for feeds and screw cutting made without removing a gear and without duplication.

(MAXIMUM BELT PULL TRANSMITTED TO THE CUTTING TOOL)

THE BOYE & EMMES MACHINE TOOL CO.

ENGINE LATHES Successors to Schumacher & Boye CINCINNATI, OHIO, U. S. A.



A Challenge Without Limitation

We challenge you to put up any job on any Cone Type Milling Machine on the market today which cannot be equaled or bettered in every sense of the word on the new

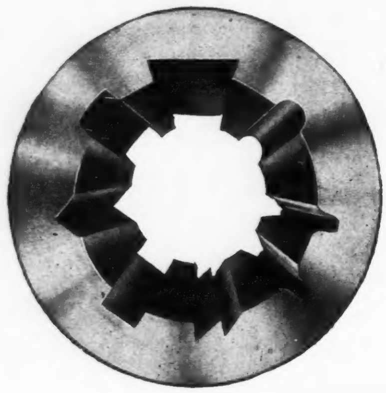
"OHIO"

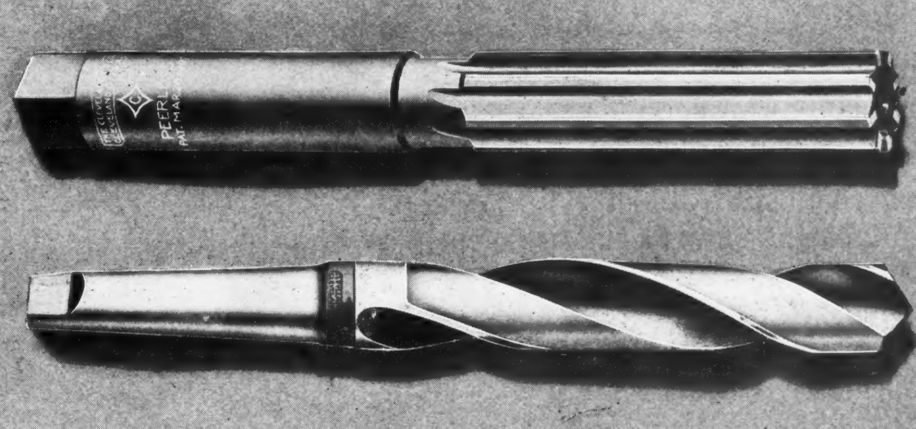
model Cone Type Miller of equal range under equal surrounding conditions. Ask us for particulars. Why not investigate?

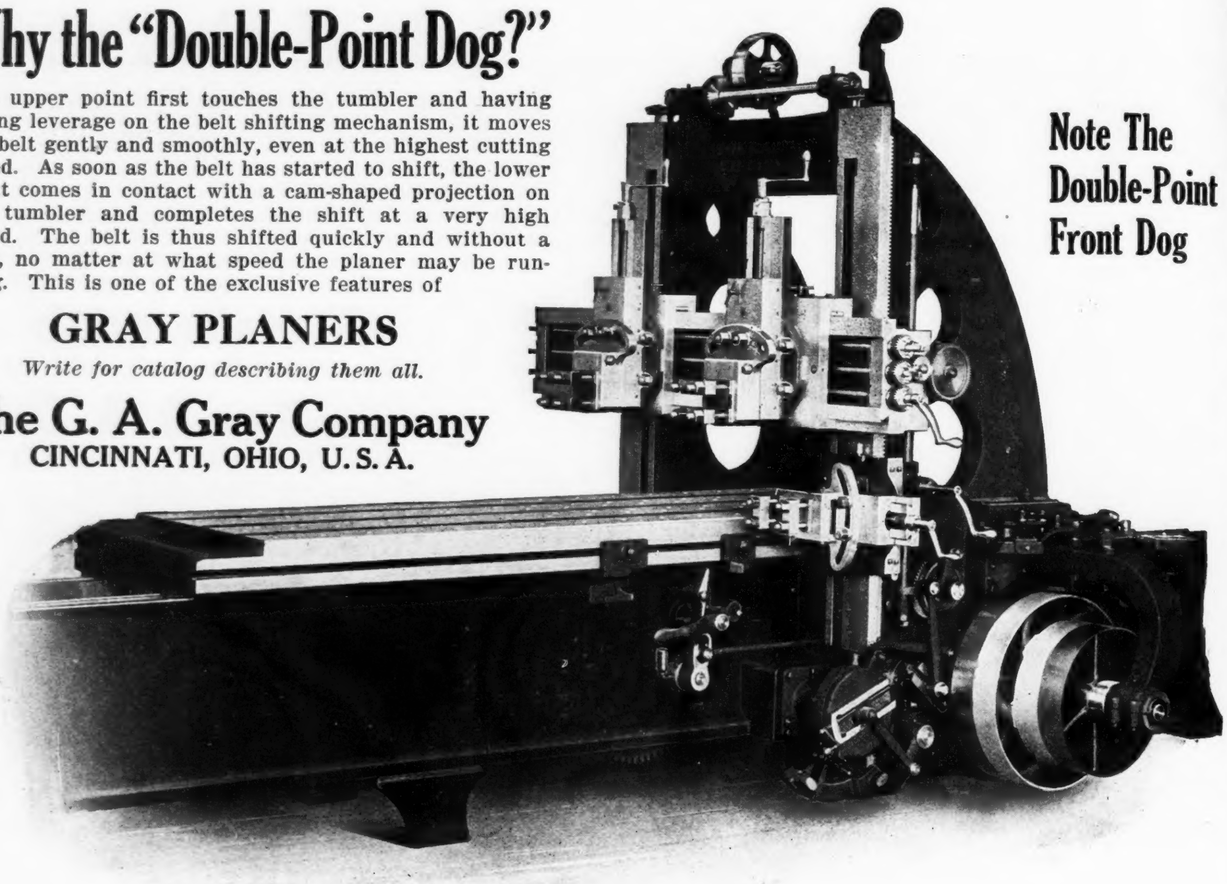
The Oesterlein Machine Company

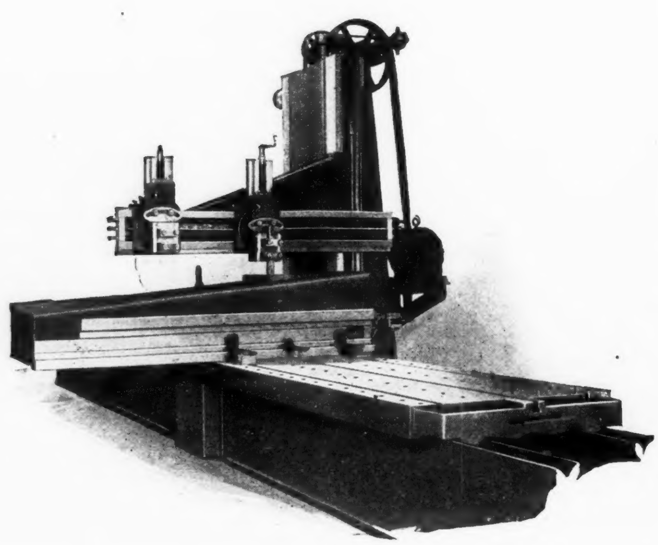
Manufacturers of Milling Machines, Universal Cutter and Tool Grinders

CINCINNATI, OHIO, U. S. A.









"SLOCOMB"

The Longest Lived Micrometer that Can Be Bought

Some of the Reasons Why

Slocomb Micrometers have many features exclusive to themselves —advantages which contribute accuracy and durability—constructional features not found in other micrometers.

The screw, or spindle, which is the heart of the micrometer, we make of the very highest quality unannealed tool steel—as hard as it can be and still be machined.

Naturally, this screw wears longer than one made of machinery steel or some other steel which cannot be hardened.

The Slocomb screw runs in a soft steel nut inserted in the frame and readily renewable. Wear takes place in the nut—the part which can be replaced at the least cost.

There are other features, too, all illustrated and described in the catalogue. It shows also the Slocomb combination sets in sizes up to 24", the new Friction Micrometer and other Slocomb tools of precision.

Ask for Catalogue 14-M.

J. T. Slocomb Company

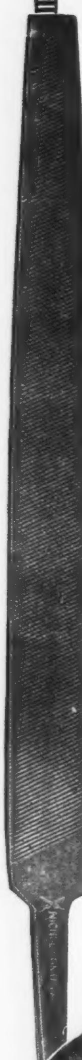
PROVIDENCE RHODE ISLAND

NICHOLSON FILES

THE BEST FILES MADE

The best—yes! and here's why:

Finest equipped file factory in the world; exclusive methods; highest grade materials; intimate knowledge of file users' requirements gained by 50 years' experience devoted exclusively to file making; world-wide sales.



NICHOLSON FILES

CANNOT BE EQUALLED

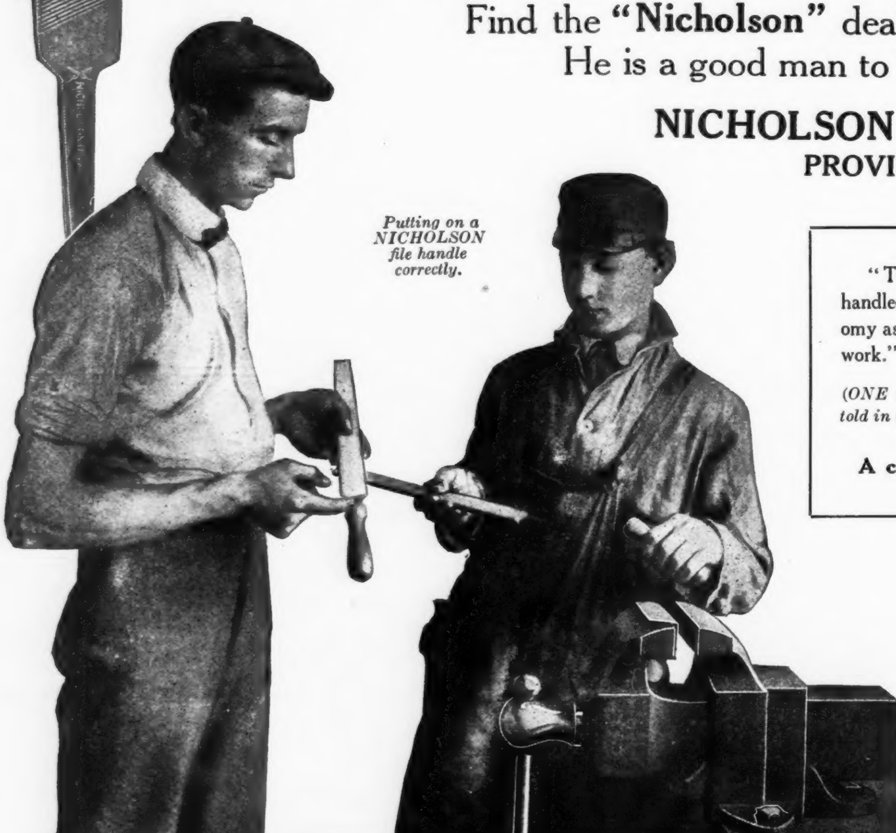
Every **"Nicholson"** file is rigidly examined for shape, cutting qualities, soundness, and temper before it is wrapped in our anti-rust paper, boxed and sealed.

These rigid examinations guarantee to the purchaser of this Company's files a uniformly high efficiency not possible by any other system.

Most every dealer can supply you with **"Nicholson"** brand files. Never sold under any other name. Boxes so plainly labeled you cannot make a mistake.

Find the **"Nicholson"** dealer in your town.
He is a good man to know.

NICHOLSON FILE CO.
PROVIDENCE, R. I., U.S.A.



Putting on a NICHOLSON file handle correctly.

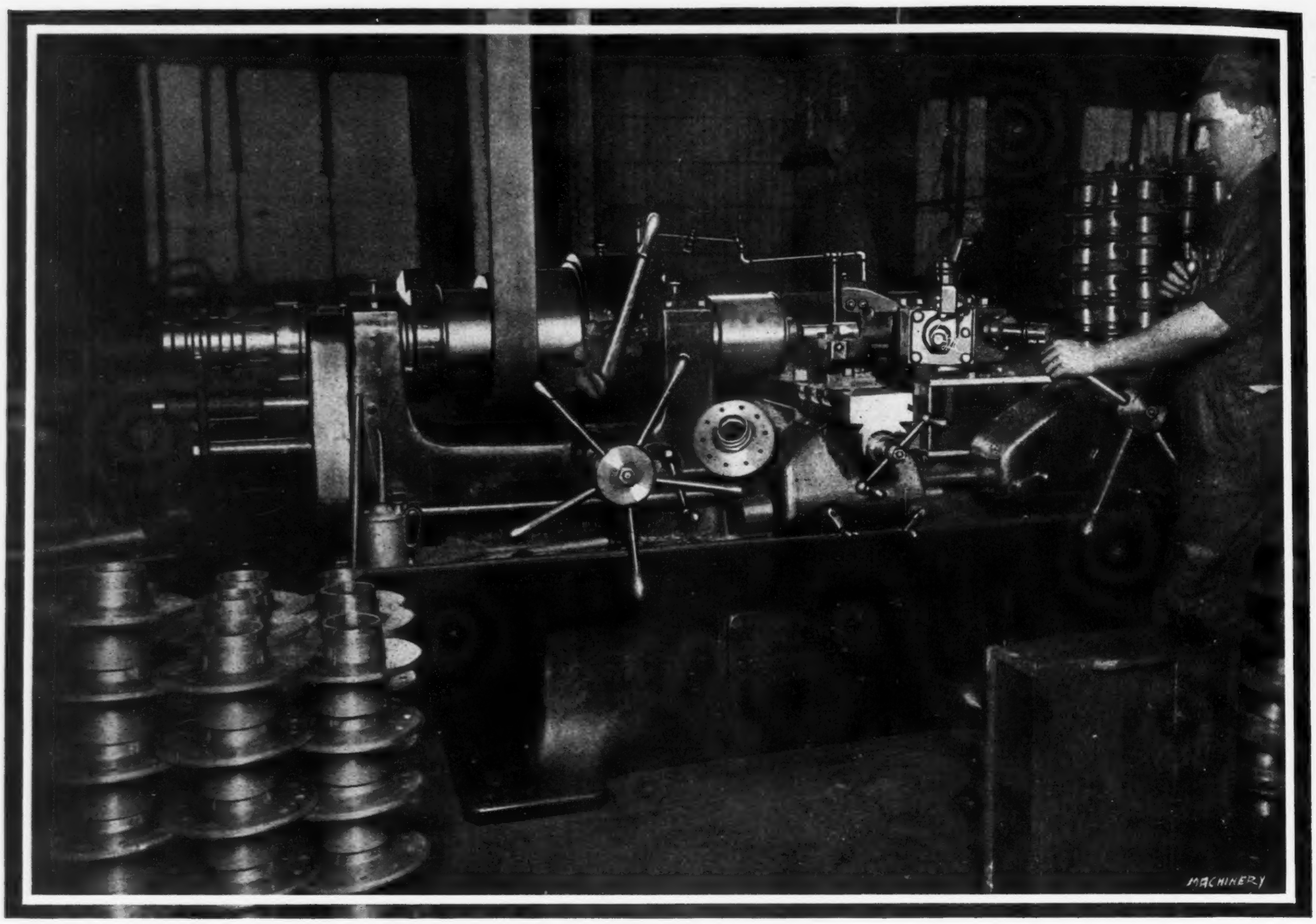
"To have the file truly and firmly handled is the first step in point of economy as well as in the production of good work."

(ONE of many valuable hints to file users told in our booklet, "FILE FILOSOPHY.")

A copy sent FREE on request

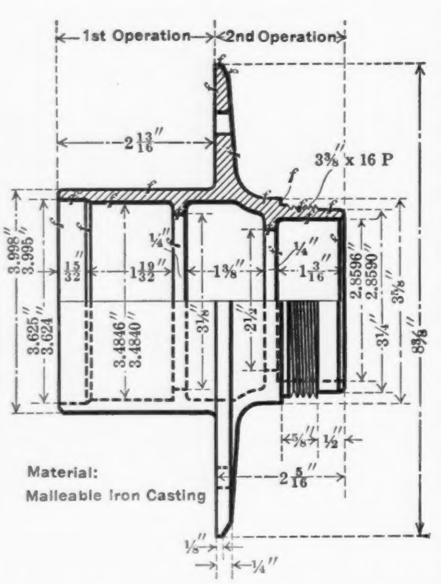
NICHOLSON U.S.A.

THE MARK OF TRADE
THAT MEANS BEST GRADE



BARDONS & OLIVER TURRET LATHES

are productive machines always. Here is a particularly good example—a malleable iron casting for an automobile wheel hub, made by the Kelsey Wheel Company, Detroit, on which two operations are necessary.



The accompanying drawing shows this hub better than it can be described; 3/32" is removed from each machined surface and all dimensions are held within close limits—one inside diameter, in particular, must be machined to a limit of 0.0006".

These limits considered, we doubt if you can find a machine to equal the output of the B & O Turret Lathe—eighty-five hubs in ten hours.

This is one of several sizes of hubs on which the Kelsey Company have found B & O machines most productive. We can, perhaps, offer suggestions which will show equal savings on some of your work. *Will you let us try?*

85 Hubs
in
10 Hours
is
"Going Some"

BARDONS & OLIVER
CLEVELAND
OHIO U. S. A.

Grind Milling Cutters More Accurately

TO grind a milling cutter accurately is fully as important as to buy a correctly formed, properly tempered cutter in the first place, for the efficiency of the tool largely depends on how well it is sharpened. Union Milling Cutters and Union Cutter Grinders are an ideal combination—the Cutter correct to begin with and the Grinder to keep it so until it is worn out.

This Union No. 2 Formed Cutter Grinder is entirely new, and, we believe, a great improvement over the old form of grinder. The grinding wheel on this new machine is mounted on a stationary vertical arbor, and the work, which is on a horizontal table, is passed back and forth across the face of the wheel. A gauge is provided which regulates the cut so that each tooth of the cutter is ground on an exact plane with the center of the cutter and equally distant.

Cutters up to 8″ diameter by 3″ face can be sharpened on this Union Grinder, which has a 6″ wheel with a 4″ adjustment to or from the work.

"Union" milling equipment is unsurpassed.

May we mail further details?

The Cutter and Drill Makers

The Union No. 2 Formed Cutter Grinder

UNION TWIST DRILL COMPANY

Twist Drills, Gear and Milling Cutters

ATHOL, MASSACHUSETTS

STOP PAYING FANCY PRICES

PATENT APPLIED FOR

Many users pay entirely too much for their hollow set screws.

They must be hypnotized, because there is no justification for fancy prices.

Combine **special steel bar stock** and up-to-date hardening with knowing how, and the product is

The "STANDCO"

That can't be beat for quality and price.

Cut with either U. S. S.—V—or Whitworth threads.

All styles of points; any length and diameter.

The "STANDCO" is NOT made of pressed steel.

SPECIFY and INSIST upon the "STANDCO"

PATENTED PROCESS CUTS COST

PATENTED

The new "Hallowell" SAFETY COLLAR of COLD-ROLLED STEEL—just out—is so NEAT and HIGHLY POLISHED that it improves the looks of any machine.

Machinery manufacturers the world over have quit making collars and now buy the "HALLOWELL"—because IT PAYS THEM.

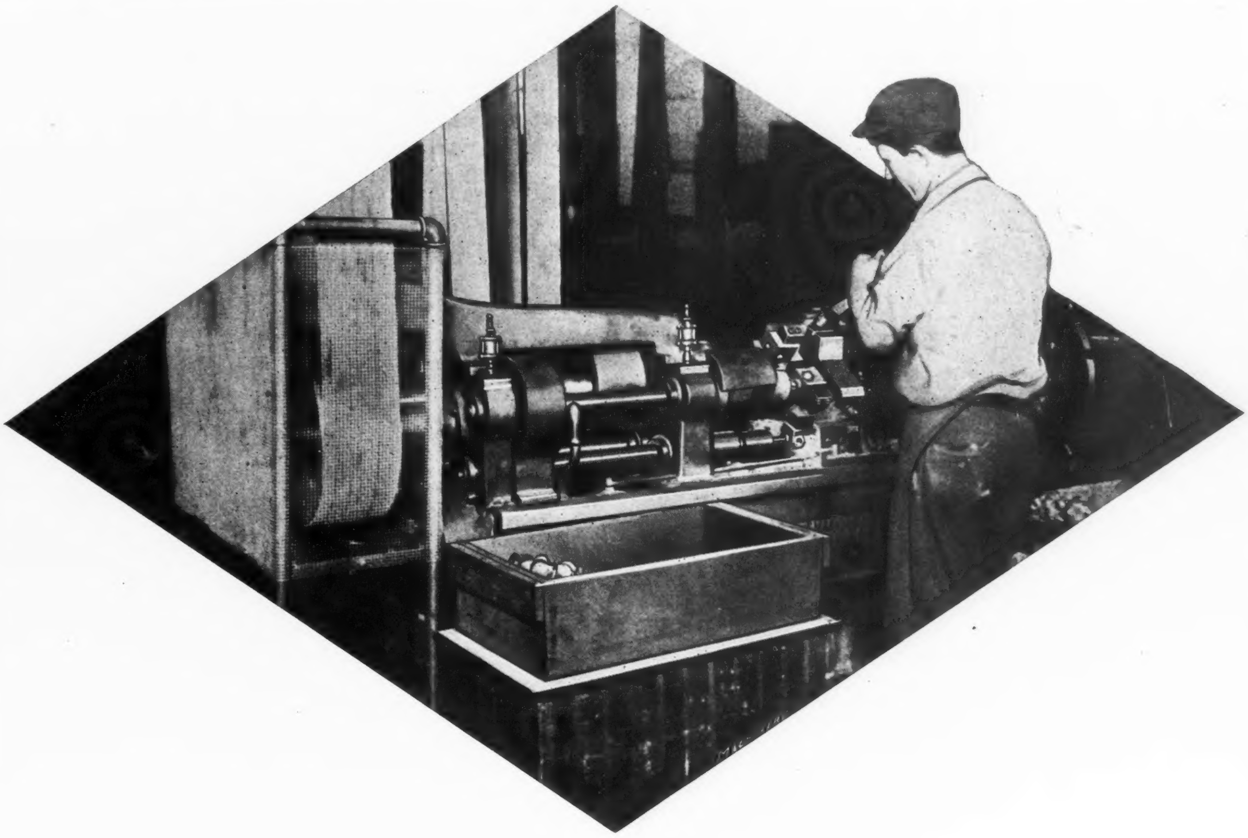
They get a FAR BETTER PRODUCT, or a MUCH LOWER PRICE, or BOTH.

Fitted with "STANDCO" if specified.

SPECIFY and INSIST upon the "HALLOWELL"

NOTE:—You might as well make your own nuts and bolts as make your own collars.

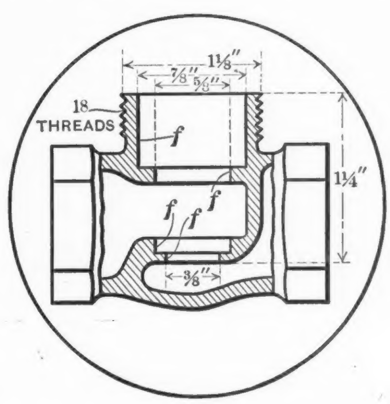
STANDARD PRESSED STEEL



One of the Latest New Britain Automatic Chucking Machines

One of the latest New Britain Automatic Chucking Machines is installed at the Hays Manufacturing Company's plant at Erie, Pa. The photograph was taken after one month's service—hardly time enough to get the machine running in good shape — yet lots of good work is being turned out every day.

The job on the machine is a good one for illustration. The sketch shows what the work is—a pipe fitting on which there is drilling, counterboring, seat finishing and threading. It is a very accurate job, the sizes being held very closely.



The speed on this work is 240 pieces per hour—every hour—ten hours a day.

How much quicker this is than the old hand turret method!

Besides being quicker, it is a more positive way of doing the work, less wearing on the operator and requiring a less skilled workman.

NEW BRITAIN AUTOMATICS

Let us show you samples of New Britain production similar to your own, or let us send estimates from your blue prints.

Write us.

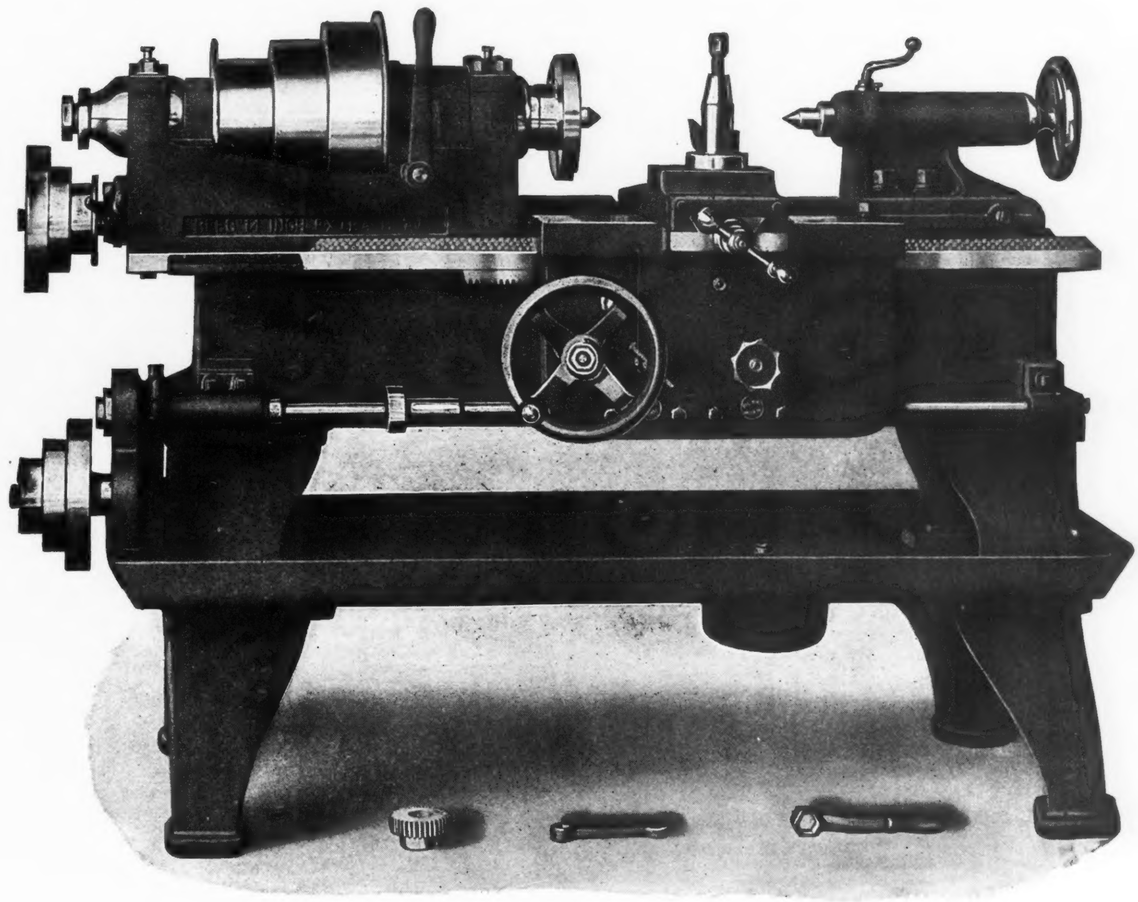
THE NEW BRITAIN MACHINE COMPANY

64 BIGELOW STREET NEW BRITAIN, CONN., U. S. A.

WESTERN OFFICE: 2008 West Grand Boulevard, Detroit, Mich.

AGENTS: Alfred H. Schutte, Paris, Cologne, Brussels, Milan, Bilbao, Berlin and St. Petersburg. Schuchardt & Schutte, London. Donauwerk Ernst Krause & Co., Wien, Prague and Budapest.

Always Come Back for More



Extra Heavy Plain Turning Lathe

This "Reed" High Power Turning Lathe is especially designed for the rapid production of duplicate parts in large quantities, at the same time maintaining, day in and day out, the highest degree of accuracy attainable.

A lathe of low swing that has all the Strength, Rigidity and Producing Capacity of the ordinary 20-inch Lathe.

With One Lever Control of Spindle for starting and stopping instantly, thus eliminating entirely the shifting of countershaft levers.

Workmanship and Material are "Reed" Standard.
Complete descriptive matter on request.

WORCESTER, MASS., U. S. A.

Brownell Machinery Co., Providence, R. I. H. A. Smith Mchy. Co., Syracuse, N. Y. Alexander & Garsed, Charlotte, N. C. Fenwick Freres & Co., Paris, France. Charles Churchill & Co., Ltd., London, England. Van Rietschoten & Houwens, Rotterdam, Holland. Moscow Machine Tool & Engine Co., Moscow, Russia. C. & J. W. Gardner Co., St. Petersburg, Russia. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. H. W. Petrie, Ltd., Toronto and Montreal, Canada.

TAPS

What if Card Screw Cutting Tools do cost more at first—"there's a reason." They wear longer, cut better, work faster and are cheaper in the long run. Card Tools are dependable; they have all the quality, uniformity, temper and finish that go to make up a high-grade tool, and when the time of reckoning arrives, the results produced by Card Taps will be found recorded on the profit side of the ledger.

If Card Taps are used in your shop, the efficiency engineer won't have to spend time on the cost sheets of your screw-cutting department.

Mansfield, Massachusetts, U. S. A.

Ltd., Paris; Fenwick Freres & Co., Turin; Ignacz Szekely, Budapest; V. Lowener, Stockholm, Copenhagen, Christiania; J. Lambercier & Co., Geneva; R. D'Aulignac, Barcelona, Spain; Arthur Kayser, Berlin, S. W. 68, Oranienstr., 126, Germany.

THE STANDARD SHIELD BRAND

METAL DRILL HOLDERS AND GAUGES


CONFUSION


ORDER

WHERE is the drill you took from your drill press a short time ago? You need it at once. No other size will do—and you cannot remember where you have placed it.

The Standard Metal Drill Holder and Gauge prevents this confusion.

It keeps the drills in plainly marked holes and in graduated size, making it possible to take out or put in any of them easily and quickly. It is always ready for systematic service. Therefore, "Put Your House—The Shop—In Order" by getting one of them—NOW.

THE STANDARD TOOL CO.

CHICAGO 552 W. Washington Blvd.	Cleveland Sixth City	NEW YORK 94 READE STREET

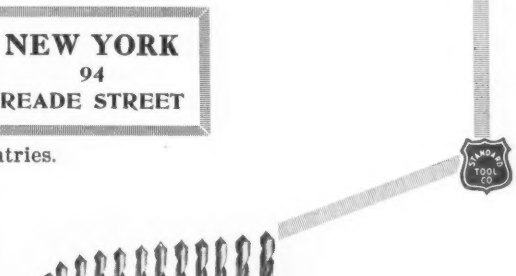
Representatives in all Foreign Countries.

This "Shield" appears on all of our DRILLS

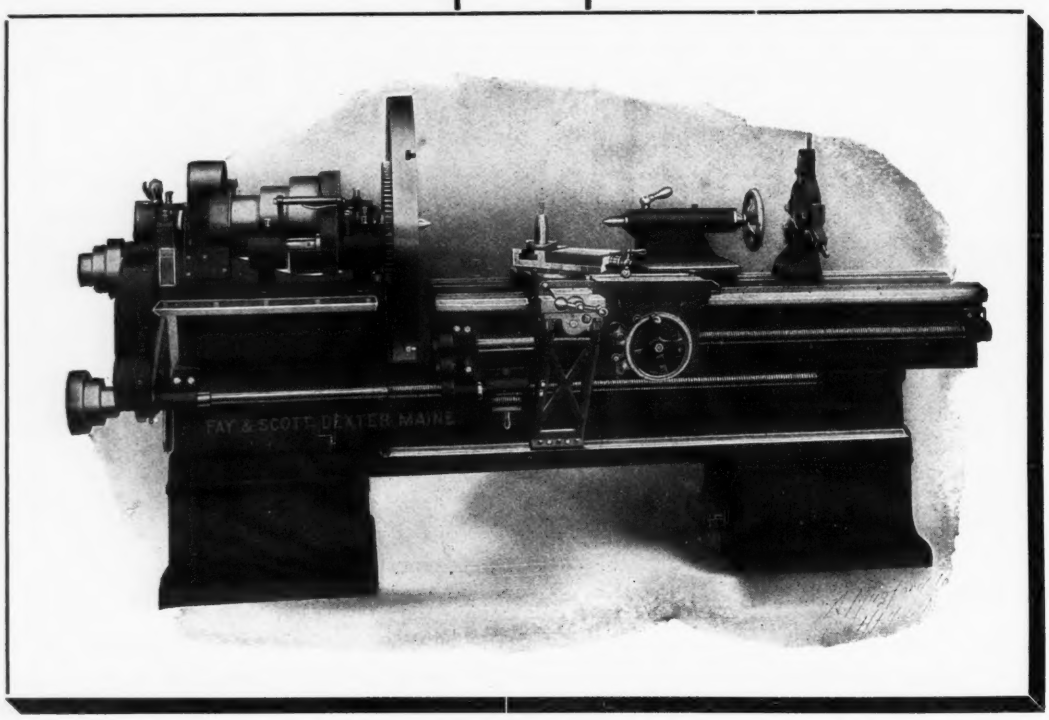
Registered

STANDARD TOOL CO.

Trade Mark



The Standard Tool Co., 1914



Concerning Fay & Scott Gap Bed Lathes

Lathes are perhaps the most important factor of shop equipment, and for that reason it pays to make careful selection.

The Fay & Scott gap bed lathe has peculiar advantages for the everyday shop. It is an all-round lathe, suited for light or heavy work and is equipped with every appliance for turning out accurate work fast. Double back gears provide wide range of feed and speed changes, the bronze spindle bearings assure perfect alignment and there is plenty of power for the heaviest cuts.

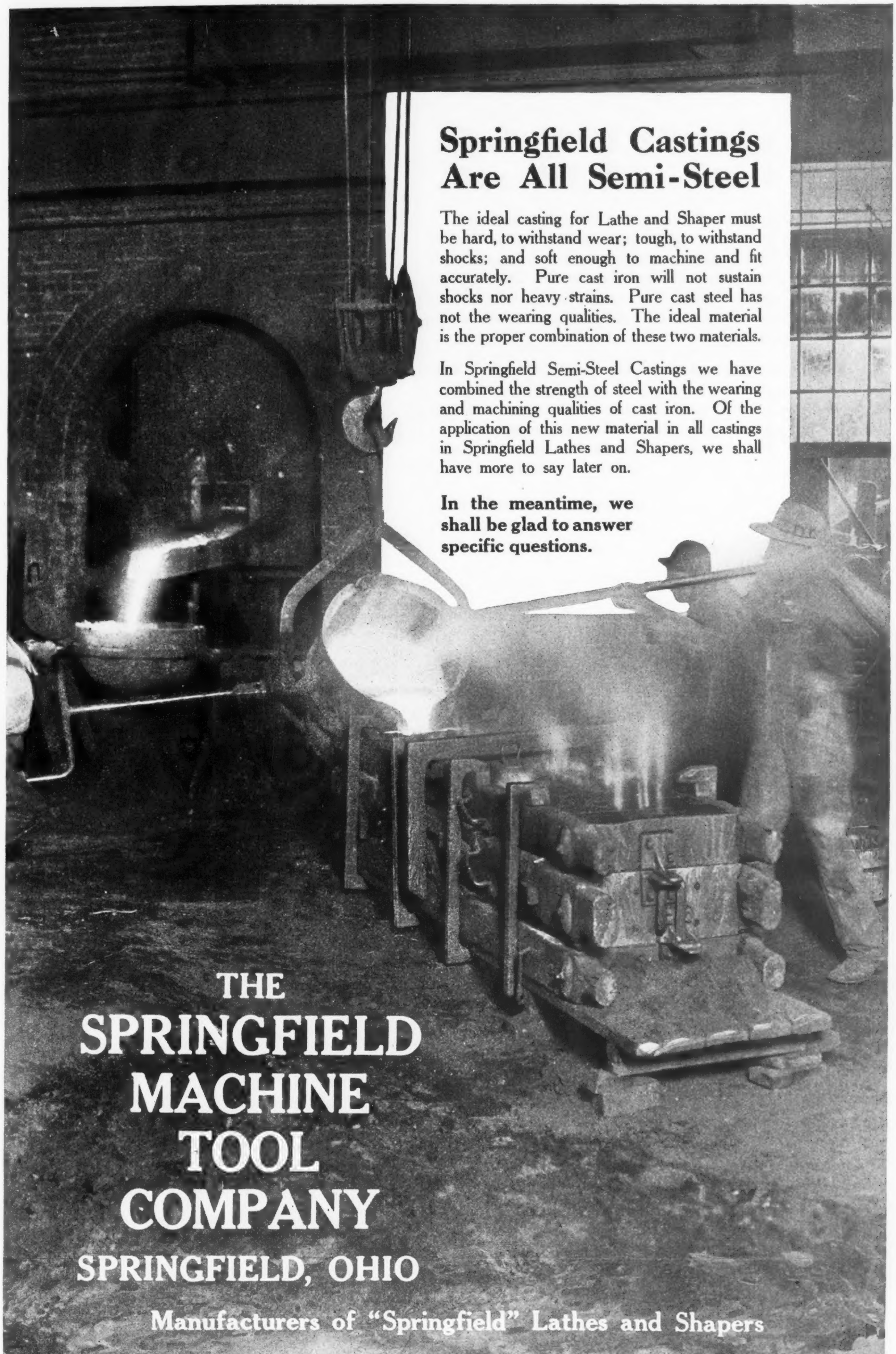
Before you purchase the new lathe you will doubtless look into the merits of various makes. Ask us about the F & S line—you can learn more about the Fay & Scott Lathes in a half-hour's talk with our representative than from all the catalogs ever issued. Drop in and see us, or let us drop in on you.

THE PRENTISS TOOL & SUPPLY CO.

Singer Building, 149 Broadway, New York

Warehouse: 439 Communipaw Ave., Jersey City, N. J.

BOSTON, MASS.	SCRANTON, PA.	ROCHESTER, N. Y.	SYRACUSE, N. Y.	BUFFALO, N. Y.
John Hancock Bldg.	720 Prescott St.	315 E. & B. Building	520 University Block	607 D. S. Morgan Building

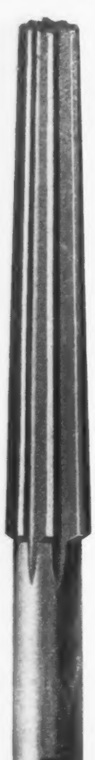

Springfield Castings Are All Semi-Steel
The ideal casting for Lathe and Shaper must be hard, to withstand wear; tough, to withstand shocks; and soft enough to machine and fit accurately. Pure cast iron will not sustain shocks nor heavy strains. Pure cast steel has not the wearing qualities. The ideal material is the proper combination of these two materials.
In Springfield Semi-Steel Castings we have combined the strength of steel with the wearing and machining qualities of cast iron. Of the application of this new material in all castings in Springfield Lathes and Shapers, we shall have more to say later on.
In the meantime, we shall be glad to answer specific questions.
THE SPRINGFIELD MACHINE TOOL COMPANY
SPRINGFIELD, OHIO
Manufacturers of "Springfield" Lathes and Shapers

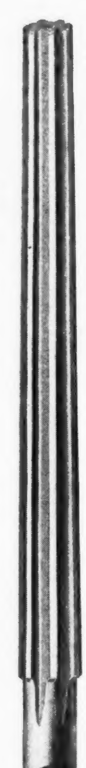
Important Announcement

We take pleasure in announcing to our customers and friends that we have now brought out a complete line of Solid Reamers. The same guarantee is back of these tools that has been back of all McCrosky products for years, which means that any tool proving defective in either workmanship or material will be replaced at once, no charge.

Our earnest endeavor to deserve our rapidly increasing business, and our sincere purpose to render real service in the larger sense, have created a confidence in McCrosky products, which we believe will find expression in a ready demand for this new line of tools.

We are in a position to quote most attractive discounts on these tools. A yearly contract with us on your complete Reamer requirements should save you money.





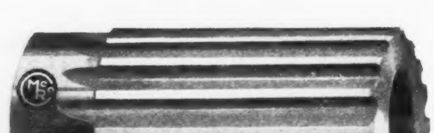
Ask for Bulletin A-4

Our McCrosky and Ideal Adjustable Reamers, Wizard Quick-Change Chucks and Collets, McCrosky Expanding Mandrels, Wizard Variable Speed and Reversing Attachments, Searchlight Universal Lamp Brackets, etc., are fully described in our general Catalog No. 4. May we send you a copy along with the Solid Reamer bulletin? It may point the way to some big savings in your production cost.

THE McCROSKY REAMER CO.

MEADVILLE, PA., U. S. A.

EXPORT AGENT—Benjamin Whittaker, 21 State St., New York

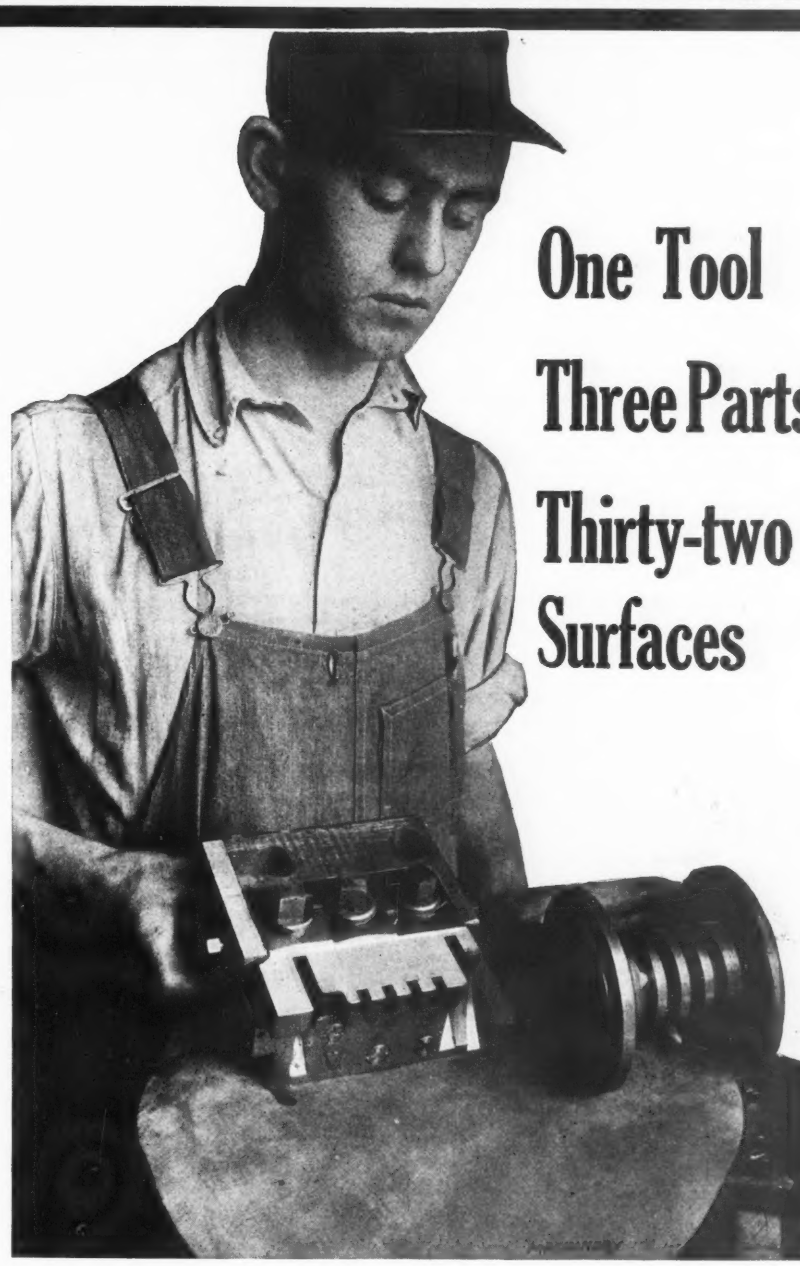


NOVO SUPERIOR

ANOTHER little facts-and-figures story which shows what can be done with Novo Superior.

This flat forming tool, 5 3-8″ width over all, is made in three parts—2″, 1 9-16″, 1 13-16″ wide, respectively. It turns the thirty-two different surfaces simultaneously and completes six of these Bessemer Steel Clutch disengaging Thrust Flanges in ten hours. It is necessary to grind only once in every fifty finished flanges.

This is a good example of what Novo Superior does for the Perry-Fay Company, Elyria, Ohio. No wonder this concern uses Novo Superior exclusively!



One Tool

Three Parts

Thirty-two Surfaces

NOVO SUPERIOR

will do the same for you. It is uniform—always the same. It requires less grinding than other high-speed steels. It is ideal for forming tools, counterboring tools, milling cutters, tips for high-speed drills, etc. It has no equal for screw machine tools.

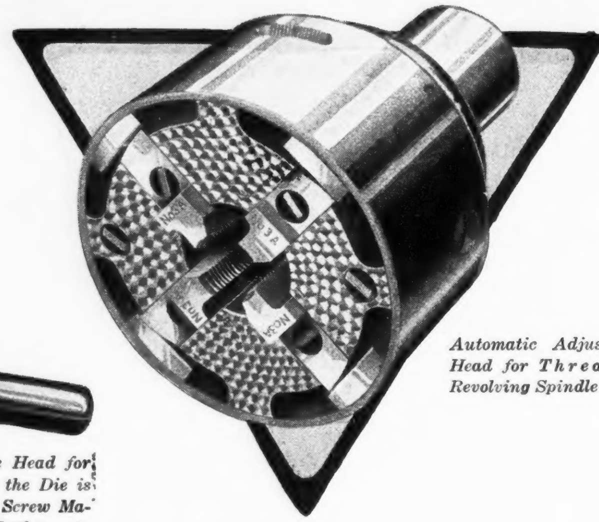
Your next high speed steel order should read "Novo Superior." Ask for the booklet.

HERMANN BOKER & COMPANY

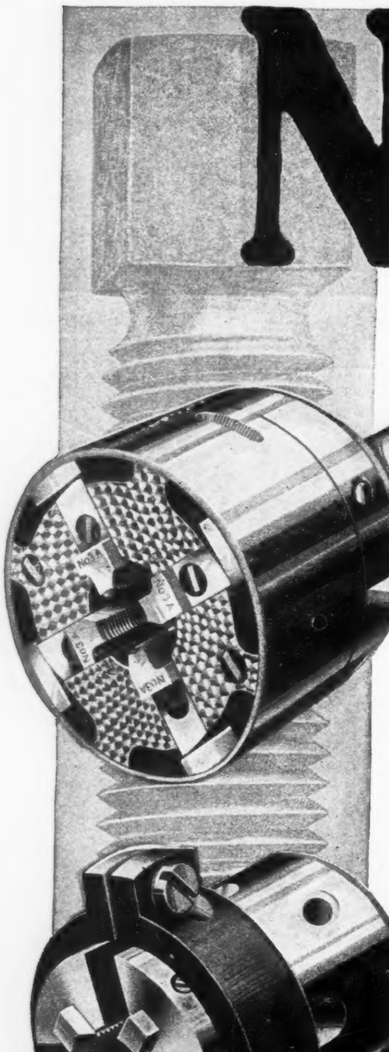
101 Duane Street Pacific Tool and Supply Company, San Francisco, Agents for Pacific Coast. **NEW YORK CITY**

CHICAGO MONTREAL PHILADELPHIA CLEVELAND

N·AMCO DIES



Automatic Adjustable Die Head for Threading on Revolving Spindle Machines.



Self-Opening Die Head for Threading where the Die is not revolved—on Screw Machines, Turret Lathes, etc.

Inserted Chasers for Pipe Threads.

Adjustable Spring Die.

For Better Threads and More of Them

The NAMCO Self-Opening Die Head is for threading on Screw Machines, Turret Lathes, and other machines where the Die is not revolved for thread cutting.

The Automatic Adjustable Head is for revolving spindle machines, or where both work and die are revolved.

On these two styles note the wide bearings back of the cutting edges of the chasers to give strength in cutting. The open design and few parts permit a free flow of oil through the tool and prevent chip clogging, making the Die substantial and practically self-cleaning in use.

The NAMCO Adjustable Spring Die has unusual thickness back of the cutting edges to give support to the Die and better lead to the threads cut. It has perfected rake and clearance for the teeth, ample chip room, and correct temper. In use, it is held rigidly accurate by the Clamp Collar, but is easy to adjust to size.

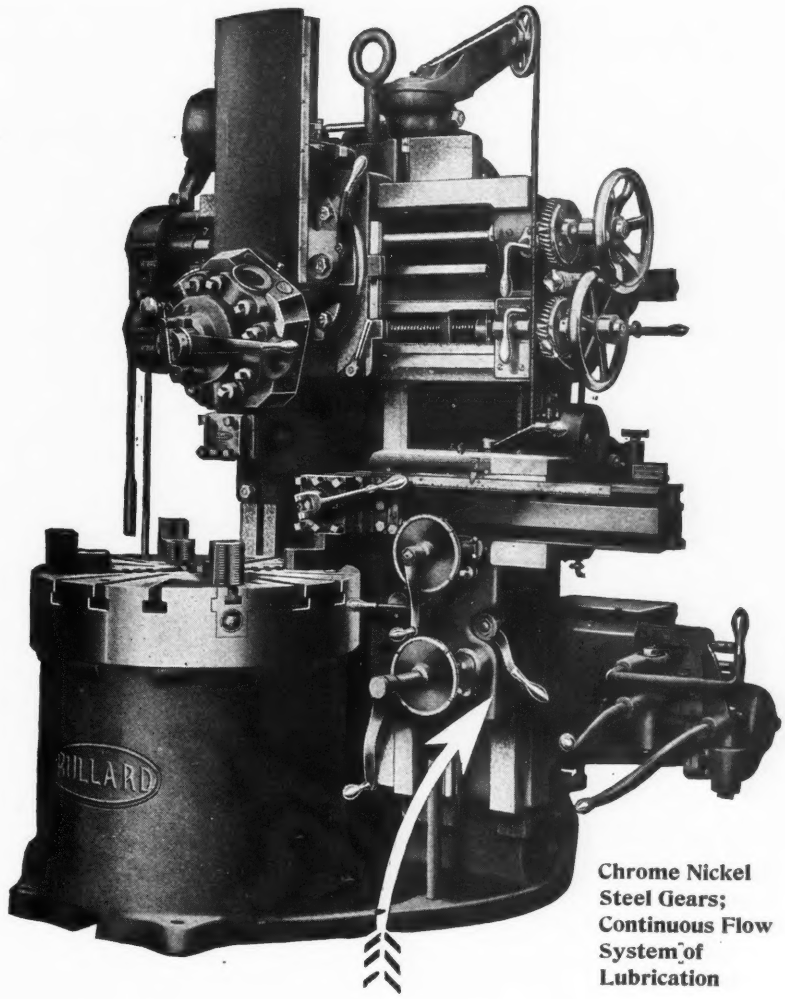
The NAMCO Pipe Die (of the Spring Die type) with Inserted Chasers, is exceptionally free cutting. Replacement of Chasers makes the Die as good as new, and is most economical for pipe threads.

NAMCO Dies are not merely theoretical tools, but embody all the improvements for substantial design, fewer parts and perfected cutting, gathered from our experience in cutting more than a million threads a year under the widely varying conditions in our product department.

We are in a position to furnish from stock the four styles of dies shown, also chasers for all standard work, and to make them up quickly for threads varying from standard. Catalogs mailed promptly on request.

THE NATIONAL-ACME MANUFACTURING CO.
CLEVELAND, OHIO

BRANCH OFFICES: NEW YORK BOSTON CHICAGO DETROIT ATLANTA MONTREAL



THE SIDE HEAD

Of The Bullard Vertical Turret Lathe

is carried by a Side Rail or vertical guide-way (patented) secured to the bed and column in such manner as to rigidly support and absorb, without chatter or vibration, the most severe strains which may be imposed on the cutting tools.
There is no overhang of the Side Head Saddle (note wide bearing in illustration) and the feeding power is applied at a point close to the work, obviating any tilting and binding tendency under cutting strain.

This construction, the result of fourteen years' experience with the type, is absolutely essential if the Side Head is to be fully efficient.

It will never be necessary to replane a Bullard bed to maintain alignment and take up wear in the Side Head bearing surfaces—the Side Rail takes the thrust and has provision for realignment. The Bullard Side Head is usable and fully efficient throughout the full actual range of the machine.

Send for Book MV-25 for full details of this and other features.

The Bullard Machine Tool Company

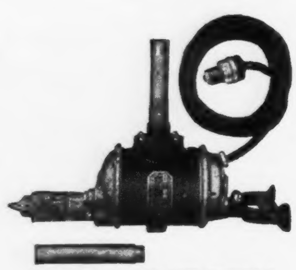
Bridgeport, Conn. **United States of America**

DOMESTIC AGENTS: Marshall & Huschart Mchy. Co., Chicago, Ill. The Motch & Merryweather Mchy. Co., Cleveland, Ohio. Seeger Machine Tool Co., Atlanta, Ga. Pacific Tool & Supply Co., San Francisco, Cal. C. T. Patterson Co., Ltd., New Orleans, La. The A. R. Williams Mchy. Co., Toronto, Ont. Williams & Wilson, Ltd., Montreal, P. Q. Prentiss Tool & Supply Co., New York, N. Y. Kemp Mchy. Co., Baltimore, Md. W. E. Shipley Mchy. Co., Philadelphia, Pa.
FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, England. Benson Bros., Sydney, Australia. Heinrich Dreyer, Berlin, Germany. Fenwick Freres & Co., Paris, France. Landre & Glinderman, Amsterdam, The Netherlands. Sam Lagerlofs, Stockholm, Sweden.

ANY TOOL SENT ON TRIAL

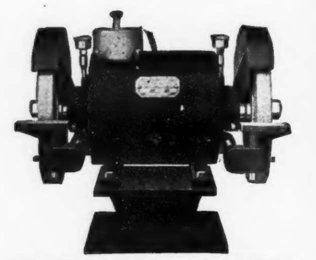
SPECIAL FEATURES

Air Cooled. Ball and Thrust Bearings. All working parts hardened. Overload allowance. Guaranteed Mechanically and Electrically.



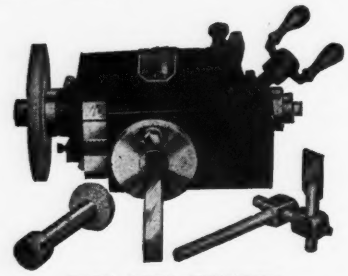
HAND OR BREAST DRILLS

¼", ⅜", ½" capacities. Weights from 7 pounds up. Gears run in grease. Single and two speeds.



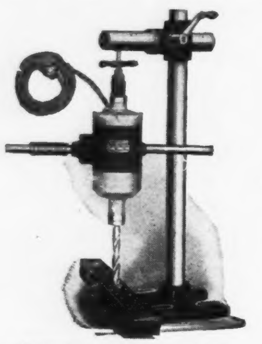
BENCH GRINDER OR BUFFER

Five sizes, ¼ to 3 H. P. Also Pedestal Floor Grinder 1 to 3 H. P. Fully enclosed. Dirt- and dust-proof.



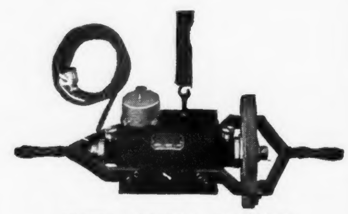
TOOL POST GRINDERS

¼ to 3 H. P. Weight from 16 pounds up. Free hand feed. Bearings adjustable to wear. Horizontal and vertical feeds. Different types for all purposes.



SCREW FEED DRILLS

With old man attachment as an extra. Drills made in 6 sizes, ¾" to 2½" capacities. Also Scotch Radial Drills.



HAND AERIAL GRINDER

For cleaning castings or surface work of any kind. Made in four sizes, ¼ to 2 H. P. Weight from 18 pounds up. End, side or adjustable body handle furnished as desired. Shaft extended for internal work where necessary. Guaranteed for hard usage.

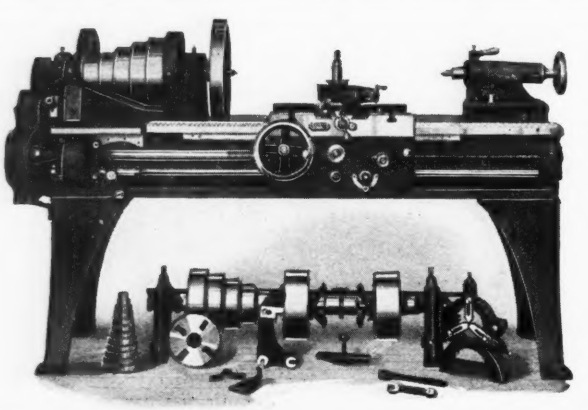
Universal Drills for Use on Either Current.

CINCINNATI ELECTRICAL TOOL CO.

Cincinnati, Ohio

NEW YORK OFFICE: 50 CHURCH STREET
STOCK AND SERVICE DEPARTMENT

CARRIED IN STOCK: New York, Manning, Maxwell & Moore, Inc.; Chicago, H. Channon Co.; Cleveland, Strong, Carlisle & Hammond Co., Pittsburgh, Somers, Fitler & Todd Co.; Baltimore, Kemp Machinery Co.; St. Louis, Sligo Iron Store Co.; Indianapolis, Indianapolis Belting & Supply Co.; Los Angeles, Union Hardware & Metal Co.; Montreal, Mussens, Ltd.; London, Universal Machinery Corporation; Christiania, V. Lowener.



A Mark of Quality

Look for the R-T Trade Mark on the next lathes you buy. It stands for everything right in lathe design. Rockford Lathes take heavy cuts in tough stock, are accurate, easily handled and rapid producers.

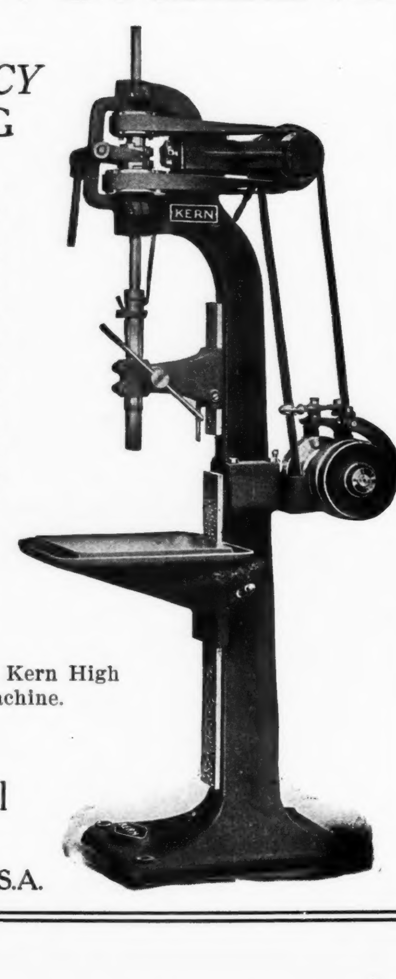
Complete details, prices, time estimates, etc., cheerfully furnished—write us.

Rockford Tool Company

Harrison Ave. and Eleventh Street ROCKFORD, ILL.

"KERN" DRILLING

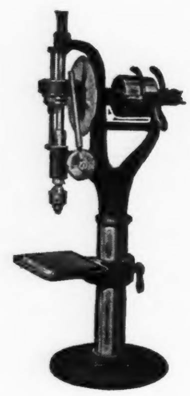
IS *EFFICIENCY* DRILLING

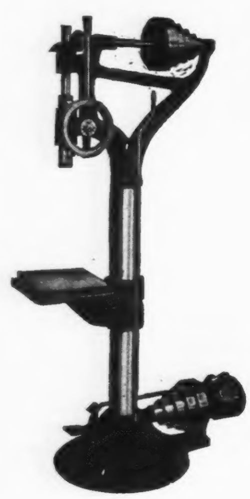


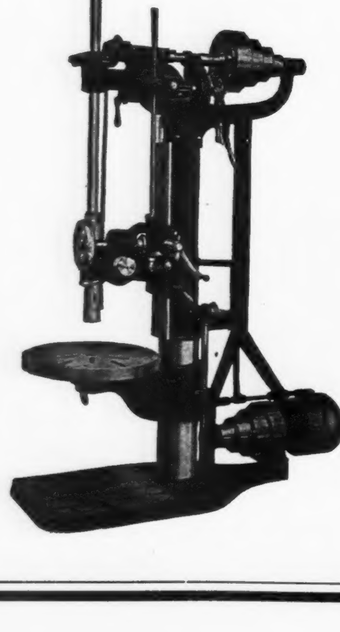
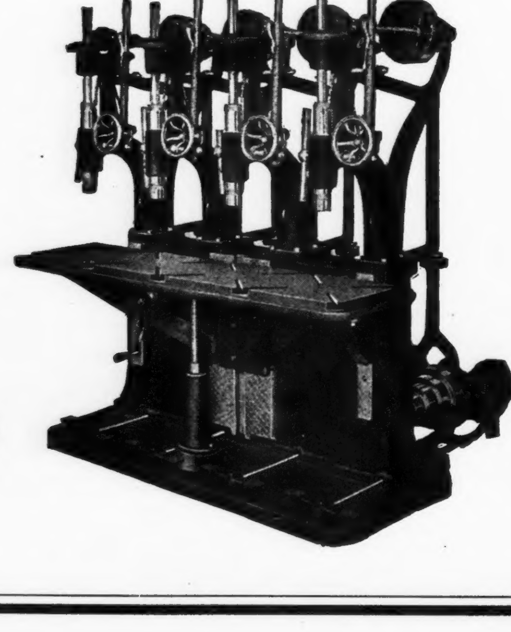
No time wasted in adjusting pulleys or tightening belts after changing speeds. The "Kern" has an endless belt drive, with four speed changes, is ball bearing throughout, has graduated spindle sleeve with adjustable collar and every other convenience.

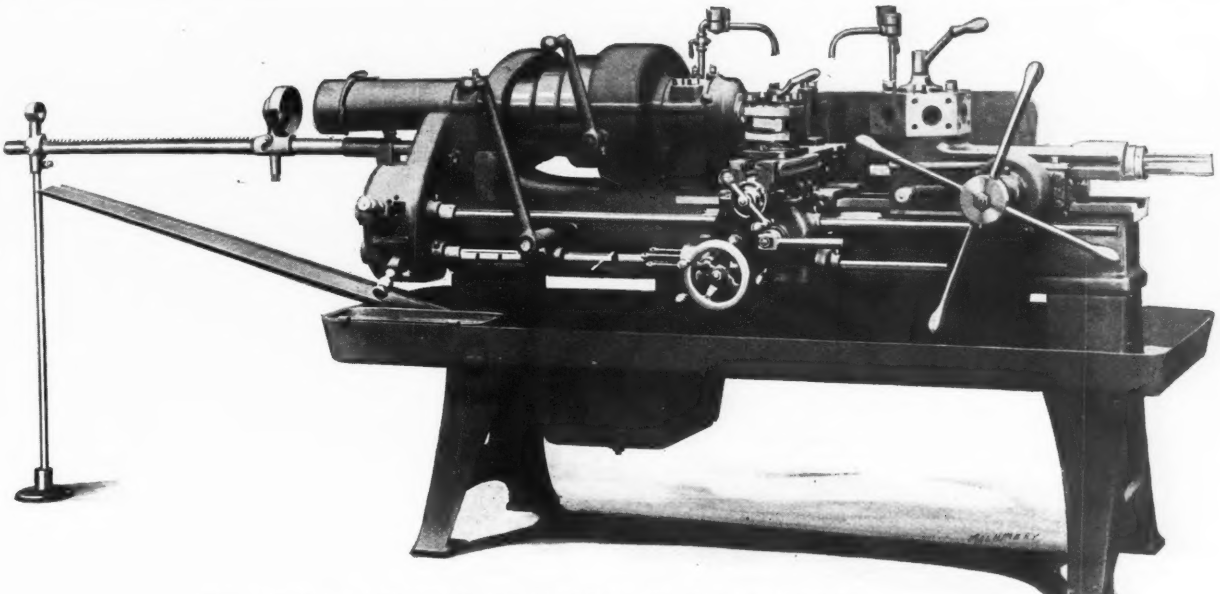
Send for the catalog and be convinced that your next purchase should be a Kern High Speed Drilling Machine.

The Kern Machine Tool Company
Hamilton, Ohio, U.S.A.





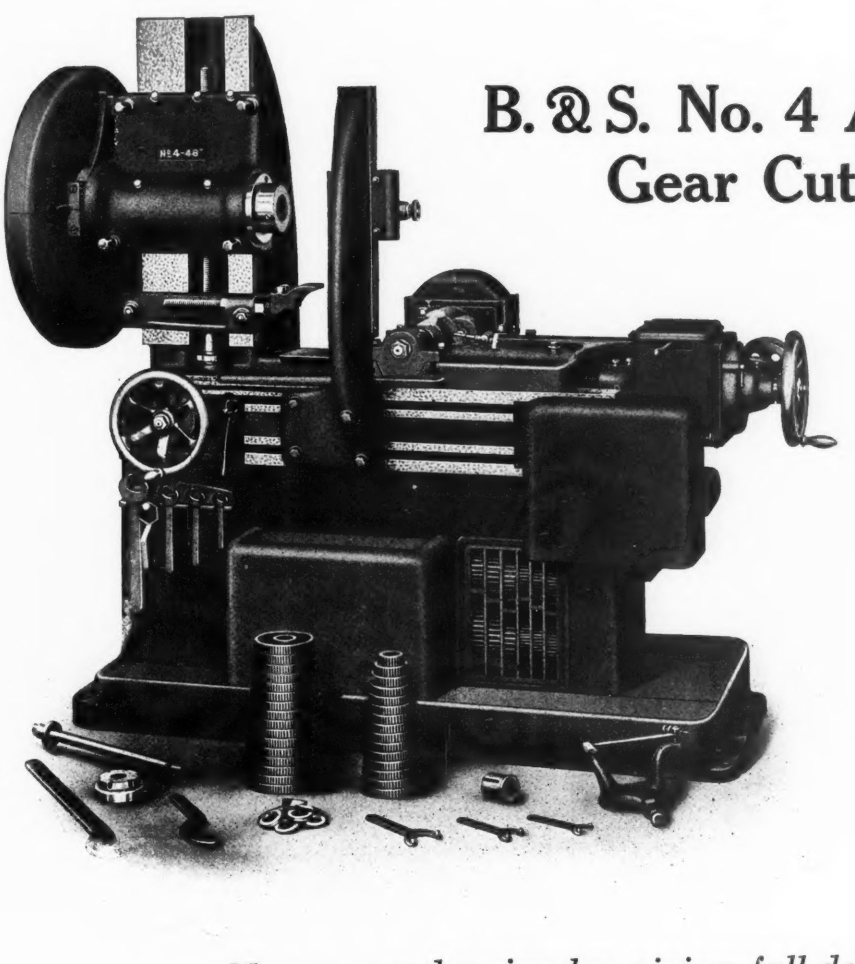
No. 4 Universal Turret Screw Machine with Bar Equipment.
Bar Capacity—1 1-2" x 10".

Quick and Accurate Indexing of the Gear Blank

THESE are important points with an automatic gear-cutting machine. Our index wheel and indexing mechanism work with rapidity and accuracy.

The indexing mechanism is positive and works without shock at a constant high speed which is independent of cutter speed or feed. It has an accelerating motion when starting, but is retarded just before stopping to avoid a jar which would disturb fine adjustments. The cutter feed is disengaged while indexing and only resumes operation on completion of indexing.

The index wheel is extremely accurate and the diameter unusually large in proportion to the size of work. The utmost care is exercised in cutting this wheel on special precision machinery. Great care is taken in finishing the bearings of the index wheel and in mounting it to avoid error at this point. By enclosing it, protection is assured against dirt and chips.



B. & S. No. 4 Automatic Gear Cutting Machine

This representative of our line will cut spur gears of any size up to 48" diameter and 10" face, using cutters to 3 diametral pitch on cast iron and 4 diametral pitch on steel.

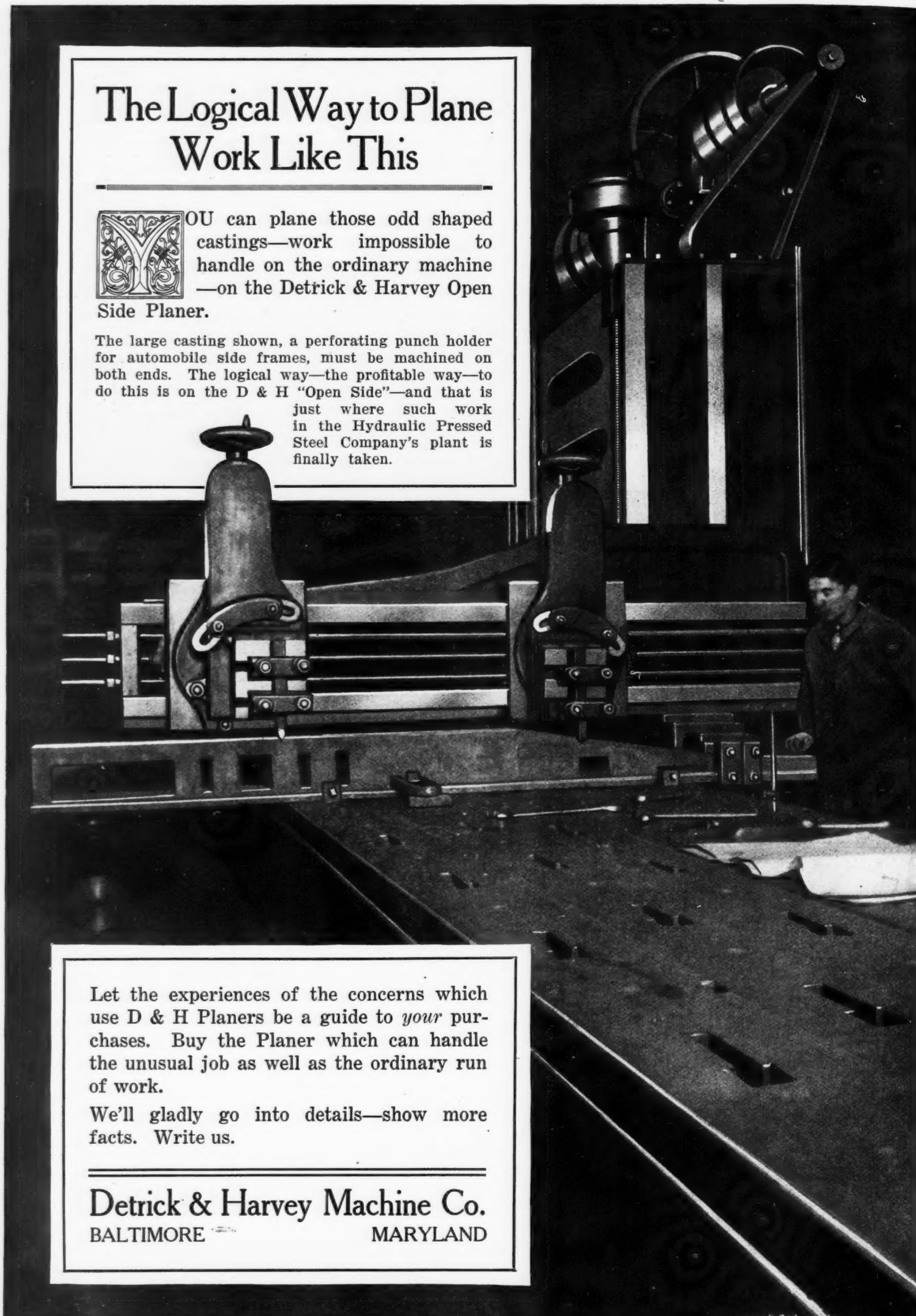
All parts are amply proportioned, while convenient control makes operation easy.

May we send a circular giving full description?

BROWN & SHARPE MFG. COMPANY

PROVIDENCE, R. I., U. S. A.

See pages 88-89



THE DETRICK & HARVEY OPEN SIDE PLANER

Thurlow Steel & Forging Co., Chester, Pa., has its plant in operation for manufacturing forgings, crankshafts, die blocks, bars, etc. The plant is equipped to produce forgings weighing from 1 to 10,000 pounds, the equipment including steam hammers and a 1000-ton forging press for heavy forgings and die work. Heat-treating furnaces have also been provided and a machine shop for roughing and finishing crankshafts, etc. The plant is under the management of John I. Rogers and Daniel C. Eagan.

Joseph T. Ryerson & Son, Chicago, Ill., announce the establishment of warehouses in St. Louis, Mo., for immediate service in their lines of finished steel to customers in the territory tributary to St. Louis. The plant, merchandise, equipment and good-will of the W. G. Hagar Iron Co. have been taken over. The facilities of this plant will be immediately supplemented with complete modern warehouses and equipment for the handling and cutting of shapes, plates, reinforcing bars and similar heavy material.

Bertsch & Co., Cambridge City, Ind., builders of shears, punches, rolls, presses and special machinery for fabricating sheet metal, plates and structural steel, have erected new machine shop and foundry buildings. The foundry is of the monitor roof type having a fifteen-ton traveling crane in the center bay. The building is heated by hot air forced draft system. Fenestra steel window sash in the side walls and monitor admit a great volume of light. The machine shop is of the same general design, having large window area. The center bay is provided with a thirty-ton traveling crane and the building is heated and ventilated by the forced draft system.

Ansonia Mfg. Co., Ansonia, Conn., has purchased the Hampden Machine Screw Co. of Springfield, Mass., and the business and equipment will be moved to Ansonia immediately. Archibald R. Lemieux, who was secretary and manager of the Hampden Machine Screw Co., becomes general manager of the Ansonia Mfg. Co. The consolidation will enable the Ansonia Mfg. Co., maker of brass goods from sheet wire and rod, wind shields, pumps and auto accessories, to serve its customers better, generally.

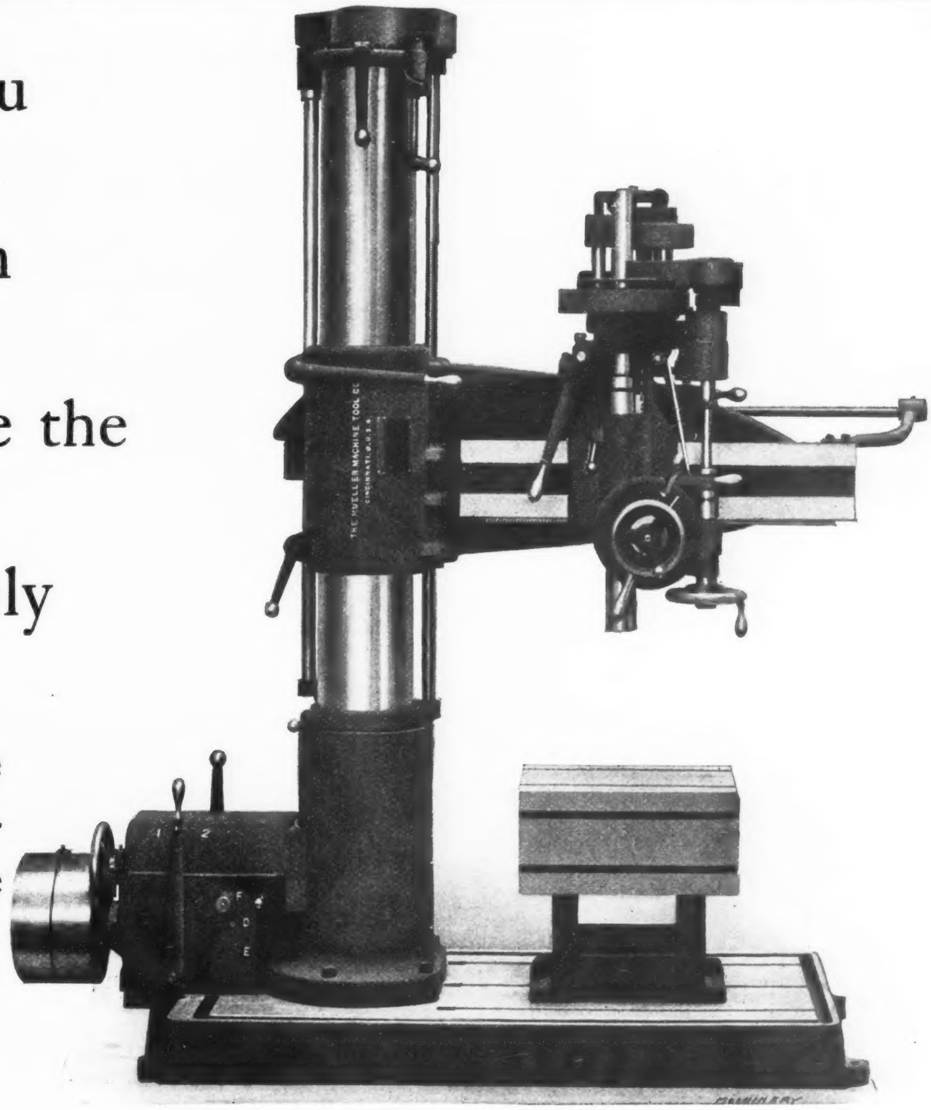
Keuffel & Esser Co., Hoboken, N. J., has moved its Chicago branch to the seven-story Keuffel & Esser Bldg., 516-520 S. Dearborn St. The company recently purchased this building and will occupy the greater part of it. It is situated near the "loop" half a block from an elevated station, midway between Van Buren and Harrison Sts., and near the important office buildings which house many of Keuffel & Esser's customers. A complete blueprint department has been installed, with much better facilities than that in the old location at 68 W. Madison St.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, is introducing a system for cooling and distributing drinking water known as the J-M system, which furnishes water at a temperature of 50 to 55 degrees F. Investigation made by Dr. Darlington, secretary of the welfare committee of the American Iron & Steel Institute, shows that water is most enjoyable at this temperature, having a stimulating action on the heart and relieving fatigue and exhaustion by equalizing the temperature of the body. The water is cooled by an A-S refrigerating machine and is then piped to bubbler fountains placed at convenient locations throughout the plant. A booklet describing the system in detail may be obtained on request.

Potter & Johnston Machine Co., Pawtucket, R. I., and the Windsor Machine Co., Windsor, Vt., have begun the erection of works at Tyseley, Birmingham, England, for the manufacture of Potter & Johnston automatic chucking machines, automatic center turning machines, automatic milling machines, automatic cutting-off machines, universal shaping machines and shaving machines, Gridley four-spindle automatic bar machines and automatic multiple-spindle drilling machines. All the foregoing machines are covered by British and foreign patents; and the establishment of the British works will enable the companies to better serve their ever-increasing number of European customers. In addition to the manufacture of the machines mentioned a specially-organized toolmaking department for the prompt filling of orders for tools required by European customers will be established. The service of this department will avoid the delays caused in transport when shipped from American shops. The new works will be ready for occupancy next fall.

Billings & Spencer Co., Hartford, Conn., has bought the plant of the Columbia Motor Car Co. of Hartford, including $8\frac{1}{4}$ acres of ground. The purchase price was \$350,000. The Billings & Spencer Co. has outgrown its present quarters, and the purchase of the Columbia factory will afford room for much needed expansion. The tract has a frontage of 221 feet on Laurel St. and 1024 feet on Park St. The land covered by buildings is 2.29 acres and the floor area of the building is 227,952 square feet. The plant is ideal for the manufacture of drop-forgings, machinists' tools, wrenches, etc. The Billings & Spencer Co., which was organized in 1872, has grown steadily, and it turns out from 10,000 to 12,000 tons of steel forgings annually. It was founded by C. E. Billings and C. M. Spencer, who were the pioneer drop-forgers in Hartford. They were interested in the Roper Sporting Arms Co. of Amherst, Mass., maker of repeating shot guns, which concern was taken to Hartford in 1868. The newly acquired plant has excellent railroad facilities, a spur track from the N. Y., N. H. & H. R. R. running into the plant which will make the handling of heavy tonnage economical.

When You Hunt for Stiffness in A Radial Investigate the Column Thoroughly



The Single Piece Column construction is one of the features of

The New Mueller Radial Drill

In the new Mueller Radial the column is one piece. The arm swings around the column, which is stationary at all times, and no matter how high up the arm may be it can be rigidly clamped to the column, and retain its rigidity.

The Mueller column is cast with four webs extending from top to bottom — practically an I-beam construction which is exclusive with this machine and which does away with all "spring" in the radial arm, no matter how severe the service required.

This exclusive Mueller column is only one of many reasons why this machine is the best buy in its field. The catalogue shows the other reasons in detail.

Send for a copy.

THE MUELLER MACHINE TOOL CO.

Radial Drills and Lathes — CINCINNATI, OHIO, U. S. A.

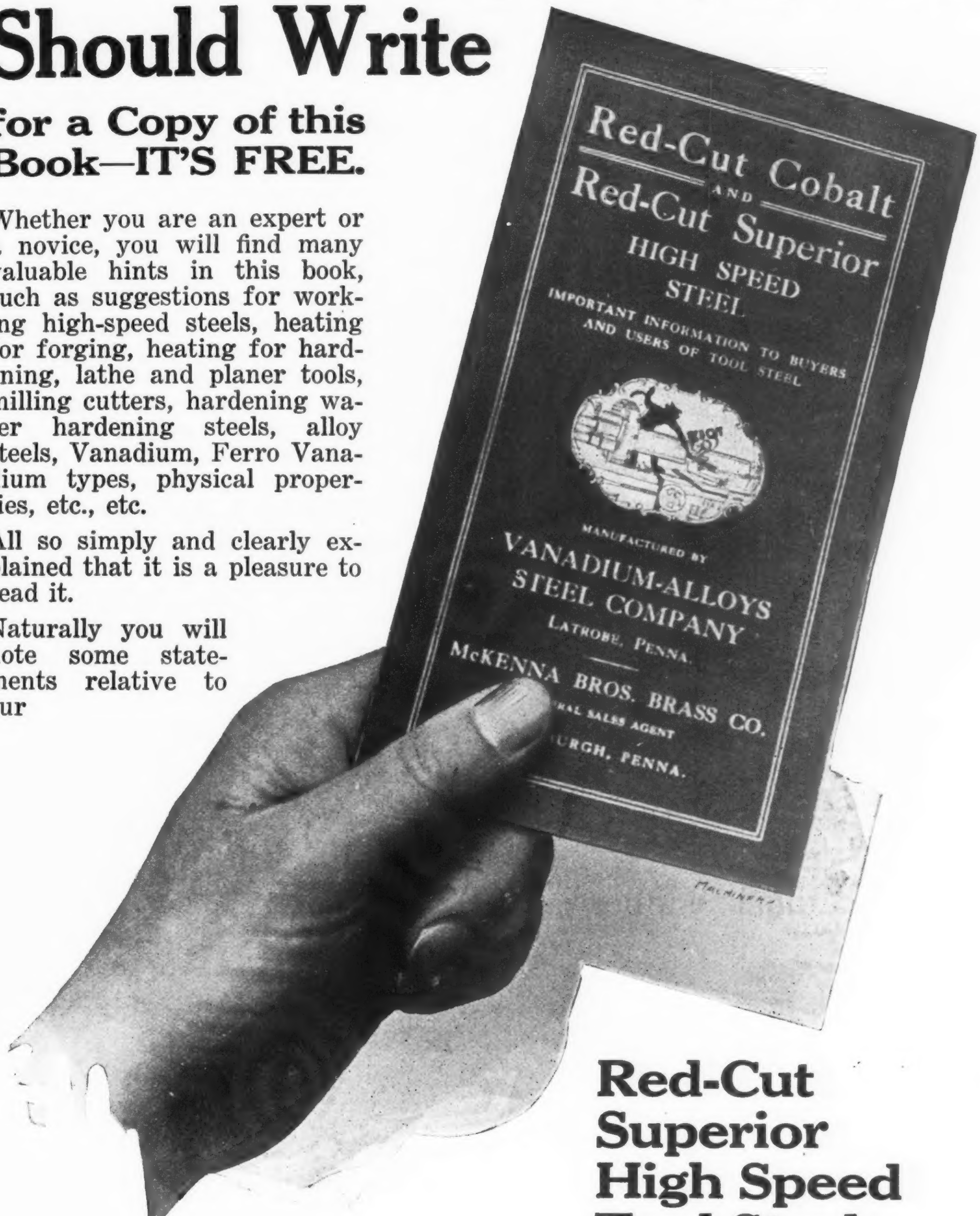
Every Man interested in the slightest degree in High Speed Steel Should Write

for a Copy of this Book—IT'S FREE.

Whether you are an expert or a novice, you will find many valuable hints in this book, such as suggestions for working high-speed steels, heating for forging, heating for hardening, lathe and planer tools, milling cutters, hardening water hardening steels, alloy steels, Vanadium, Ferro Vanadium types, physical properties, etc., etc.

All so simply and clearly explained that it is a pleasure to read it.

Naturally you will note some statements relative to our



Red-Cut Superior High Speed Tool Steel

Superior in Name and Performance

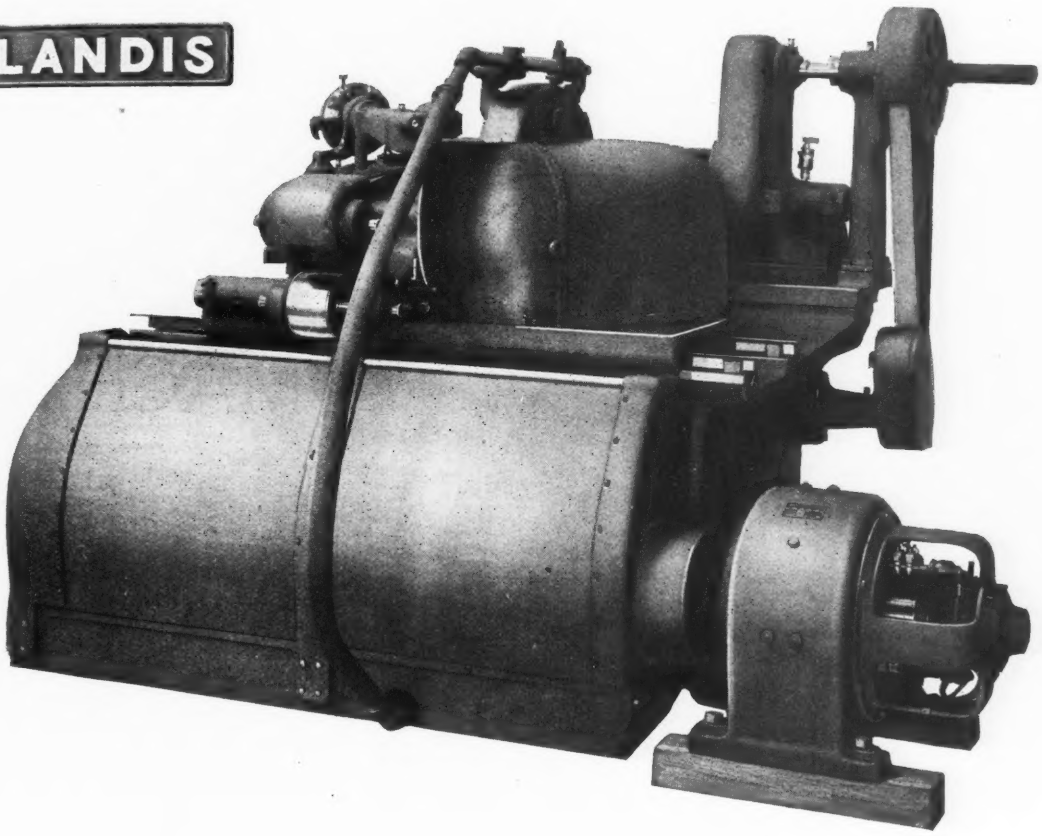
VANADIUM-ALLOYS STEEL CO.

PITTSBURGH, PA., U. S. A.

CHICAGO ST. LOUIS DETROIT CLEVELAND BUFFALO CINCINNATI BOSTON PHILADELPHIA

Grinding Machine Design

LANDIS



for the operator; wheel trued in any position of its travel without removing the work; LANDIS simple positive reversing dogs; and the LANDIS wheel feeding and sizing device as well as the LANDIS wheel balancing device.

Conspicuous in the construction of this improved machine are: bronze bearings in parts subjected to wear; hardened and ground spindles provided with complete continuous lubrication; wheel spindle bearings, self-compensating for heat expansion and adjustable for wear; centralized oiling system; ball bearings wherever practical; clutchless device for starting and stopping the work independent of the wheel traverse; single lever starts or stops work and traverse simultaneously; variable tarry device for regulating the duration of the pause of the wheel carriage at reversing points; work rests with stops for limiting the feed; powerful belted drives—especially noticeable in the one directly connecting the wheel spindle pulley to the main drive; and complete separation of the variety of independent work and traverse speeds.

We'll be glad indeed to show you what this machine does as well as what it is. Write us, now.

AND WORKS: **Waynesboro, Pa., U. S. A.**

Crank Grinding Machines Internal Grinding Machines Cam Grinding Machines

Street, Walter H. Foster, Company, Managers.

Ernst Krause & Co., Wien, Prague and Budapest. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Can. Andrews & George, Yokohama, Japan. M. Buarque & Co., Rio de Janeiro, Brazil.

THE center line of the headstock and tailstock is back of the center line of the bed in Greaves-Klusman Engine Lathes. This feature eliminates tool overhang and permits the use of an extra large driving cone, which furnishes more power than is possible to obtain from other lathes of equal swing.

No Tool Overhang Means More Power

Further particulars on request. Write today.

"G-K" Engine Lathes

have a heavily reinforced bed construction directly under the "Vs" which minimizes torsional strains in the bed. Every operating convenience is embodied in G-K design. These lathes are easy to run, long wearing and accurate.

The Greaves-Klusman Tool Company

CINCINNATI, U. S. A.

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FOREIGN: Ward & Co., Birmingham. R. S. Stokvis & Zonen, Ltd., Holland and Belgium.

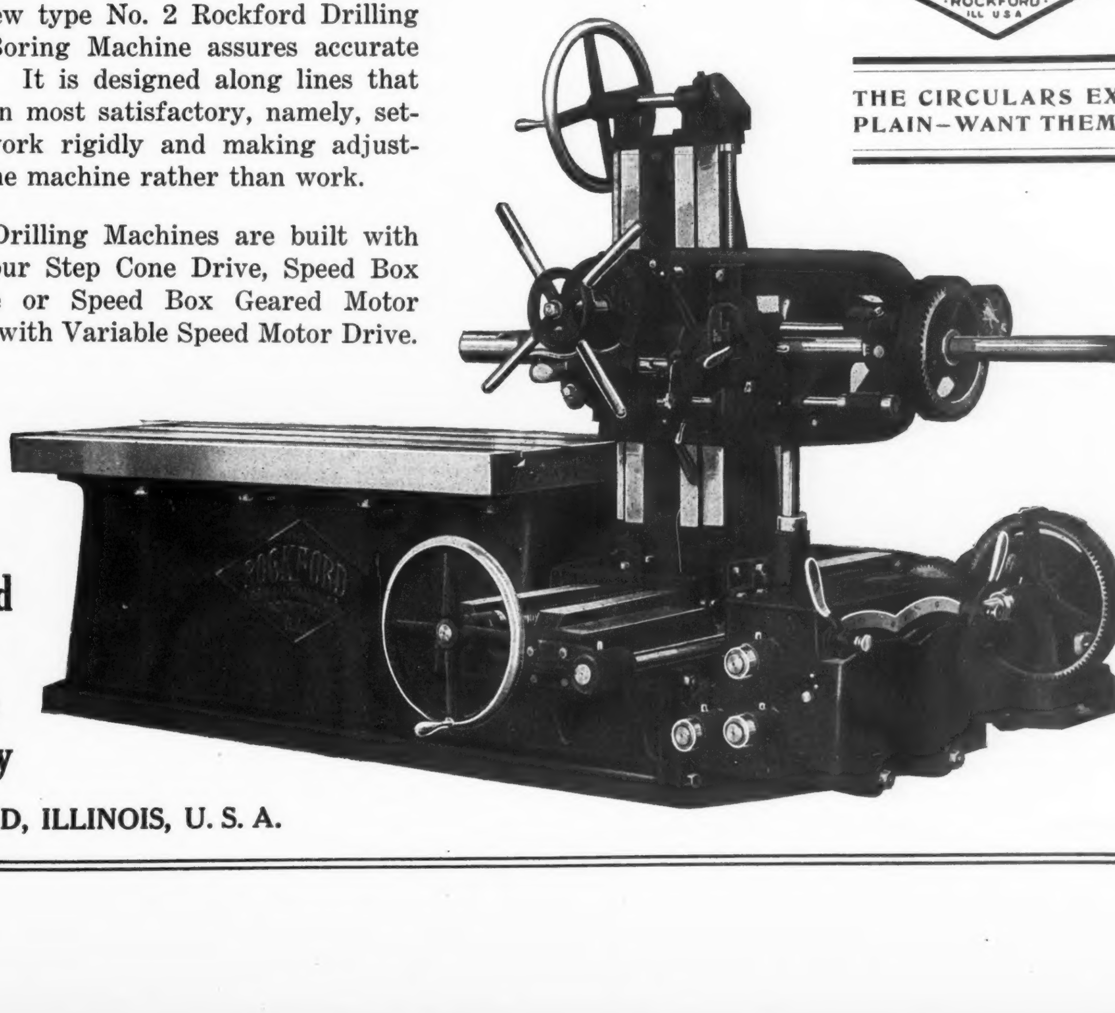
Set the Work—Then Adjust Machine

THE ROCKFORD DRILLING MACHINE Co. ROCKFORD ILL. U.S.A.

THIS new type No. 2 Rockford Drilling and Boring Machine assures accurate work. It is designed along lines that have proven most satisfactory, namely, setting the work rigidly and making adjustments of the machine rather than work.

THE CIRCULARS EXPLAIN—WANT THEM?

Rockford Drilling Machines are built with Two or Four Step Cone Drive, Speed Box Belt Drive or Speed Box Geared Motor Drive, and with Variable Speed Motor Drive.



The Rockford Drilling Machine Company

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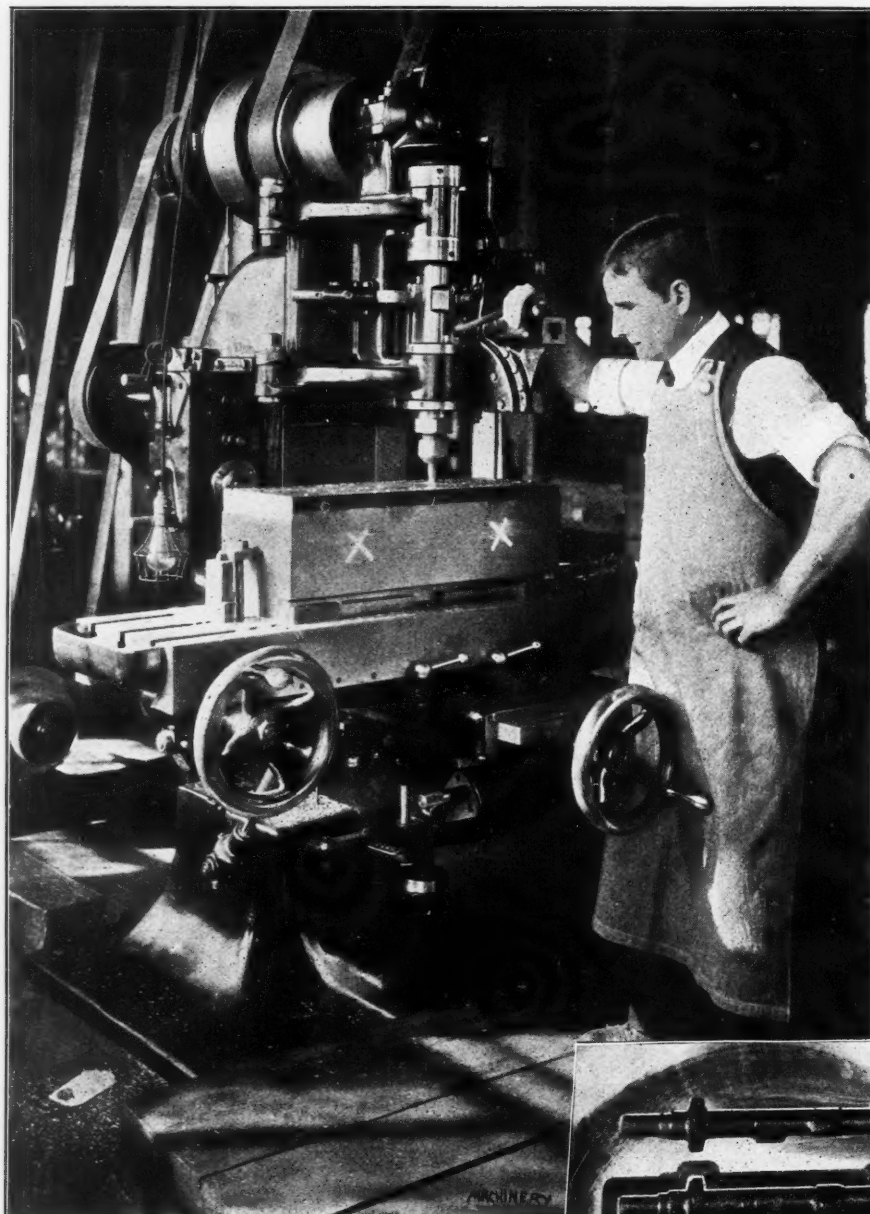
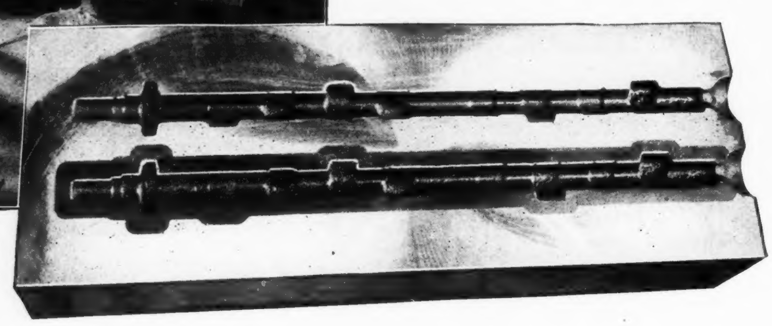


Everything But the Cam At One Setting



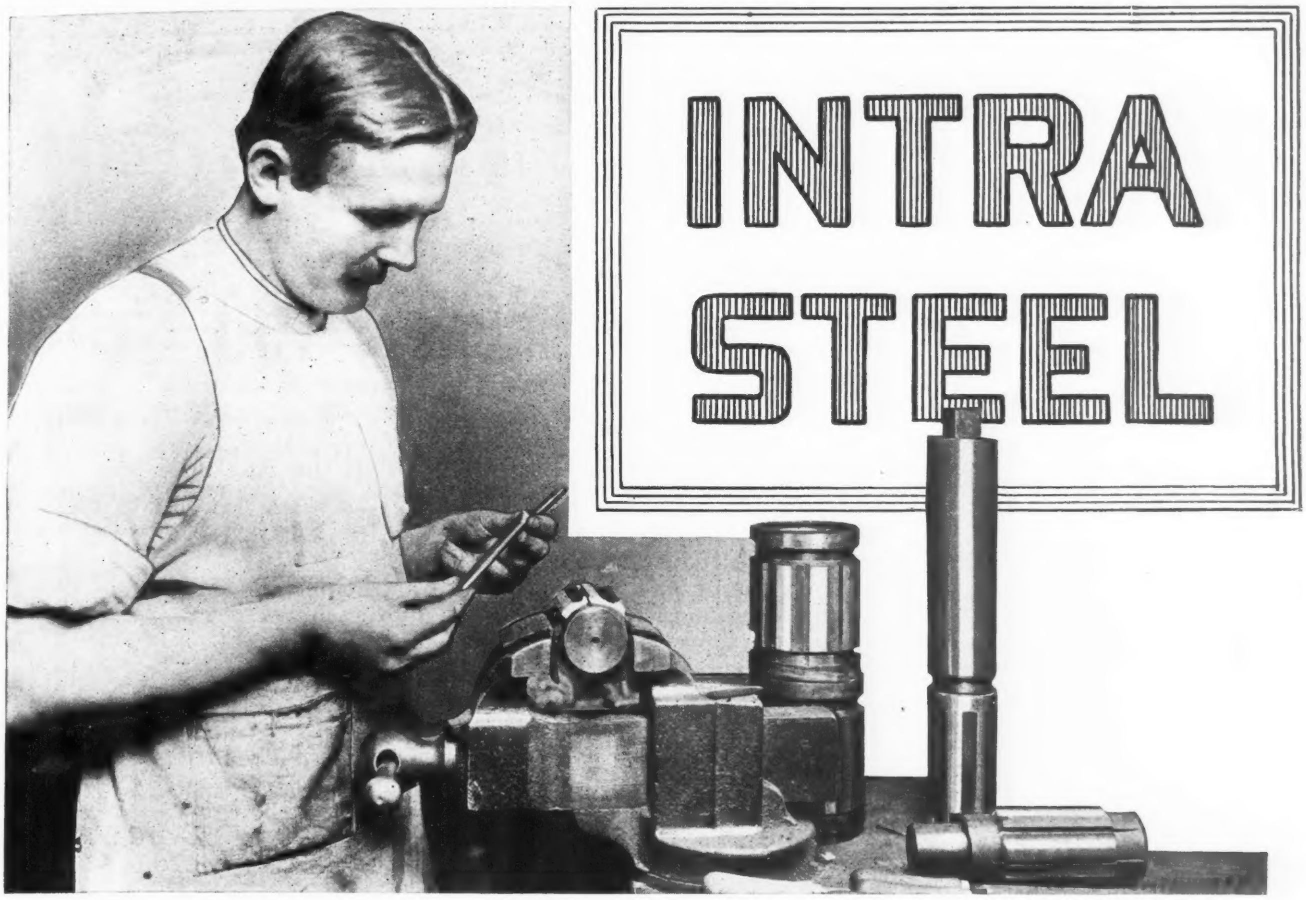
The Jackson Duplex Die Sinking Machine finishes everything but the cam on this drop forge camshaft die at a single setting of the work. You know what this means—the elimination of nearly all the bench work in die sinking and the saving of about 50 per cent in the cost of the average die. The Jackson Machine will pay for itself in most shops in a very short time. One user said: "It is a gold mine"—and he is right.

You can't afford to be without this machine. It is a big profit earner. The "cherrying" attachment enables holes to be "cherried" *below center*, and when the work leaves the machine it is finished *completely;* no hand work is necessary.

We'll gladly show you how to save 50 per cent on this work· We'll send a representative or the bulletins on request. Write us now before you forget.

JACKSON MACHINE TOOL COMPANY

JACKSON, MICHIGAN, U. S. A.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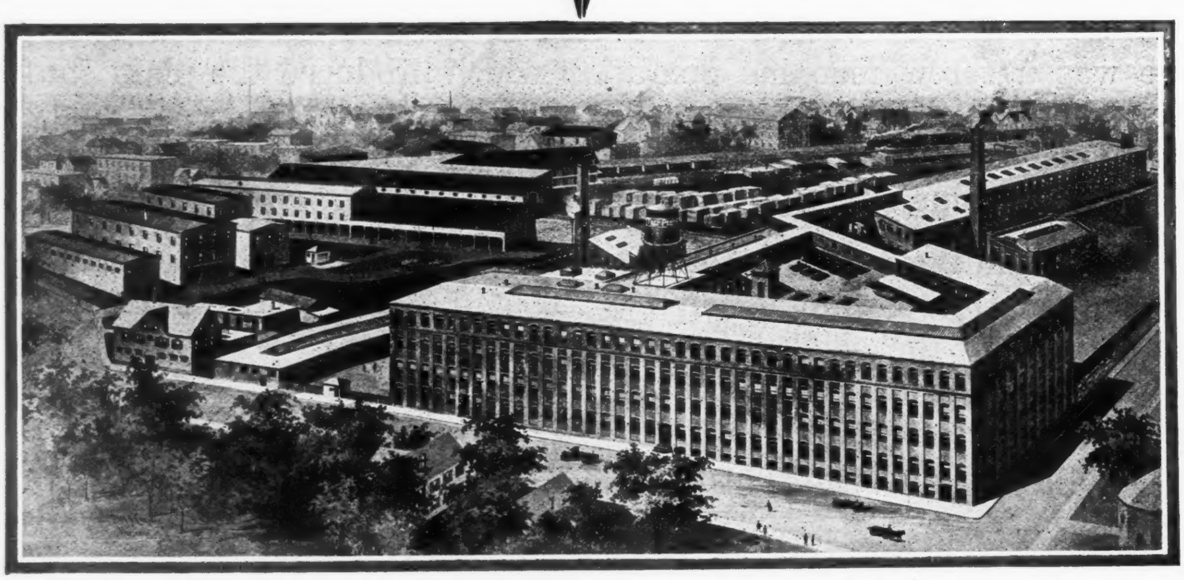
TAFT-PEIRCE
TRADE MARK

Screw Machine Service is Better

If you require "Screw Machine Parts" made in either small or large quantities that demand a little more accuracy than the average so-called "Screw Machine Product," submit us your blueprints for prices.

Our equipment embraces Hand Screw Machines of all sizes and Single Spindle Automatics with a capacity from the smallest sizes up to 3″ in diameter. We guarantee accuracy and prompt delivery. In other words REAL SERVICE.



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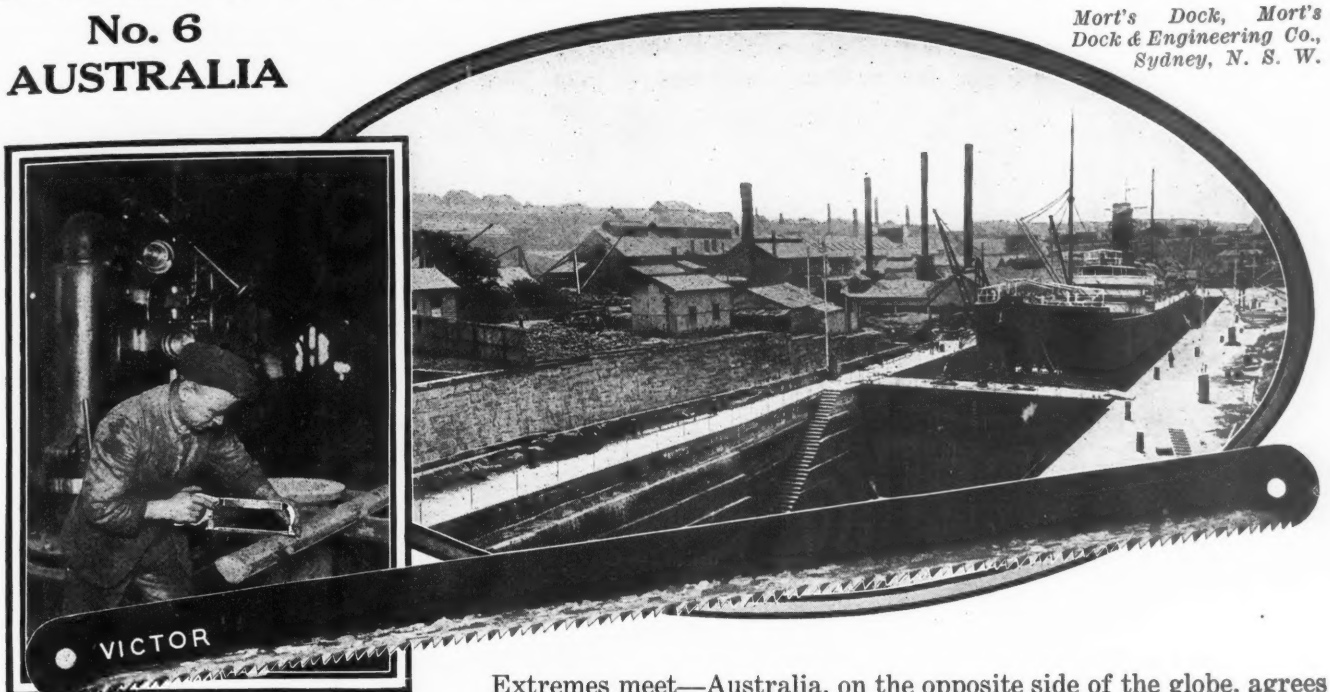
NEW YORK ←— District Sales Offices —→ DETROIT

Around the World with the VICTOR

No. 6 AUSTRALIA

Mort's Dock, Mort's Dock & Engineering Co., Sydney, N. S. W.



In Australia the relations between workman and employer are rigidly regulated by a system of industrial arbitration.

The average weekly pay is: Fitters and turners, $17.50; machinists, $15.00; toolmakers, $15.00.

"Dirt money," two cents extra per hour, is paid for especially dirty work.

A full week is forty-eight hours. Regular half holiday every Saturday, and nine full holidays during the year.

Overtime is at rate of time and a half—not over twenty hours overtime in any one week.
Night shifts are paid time and a quarter for not over five nights per week.

Apprentices have to serve for five years before drawing regular wages, and usually do not pay for privilege of learning trade.

Most mechanics belong to trade unions which act independently, but under a controlling body, The Trades and Labor Council.

Old-age pensions are paid by the Government at the age of sixty-five, or for permanent incapacity at the age of sixty, not to exceed $125 per year paid in fortnightly instalments.

Under the Workmen's Compensation Act, in case of death from accident the employer pays $1000, or a sum equal to three years' earnings, but in no case to exceed $2000.

Workmen's Loan Banks are not established in Australia. Savings Banks are conducted by the Government.

Extremes meet—Australia, on the opposite side of the globe, agrees with America that there's nothing to it but

VICTOR Hack Saws

The Australian railroads—government owned—use VICTOR Hack Saws in their shops and on their tracks. The leading shipyards and engineering concerns like Mort's Dock & Engineering Company—one of the biggest in the Commonwealth—have proved that VICTORS do more work in less time, and at smaller cost for blades and wages, than any other make.

VICTORS will prove the most efficient and economical blade for *your* work.

VICTOR All-Hards, made of VICTOR Private Formula Steel carefully milled, scientifically hardened, set with VICTOR Patent Shear Set which prevents binding, lessens crooked cutting and practically eliminates stripping of teeth.

VICTOR Flexibles, made exactly like VICTOR All-Hards, except the teeth are tempered *entirely* for *cutting* qualities, and back is left flexible. Will not break unless intentionally abused. Will outcut and outlast any blade made for hand frame use—all hard or flexible.

VICTOR All-Hard Power Blades—the VICTOR idea applied to power machine blades.

"Get a box and try 'em." Be sure to get the VICTOR that is made especially for the material you have to cut. Ask your dealer, or write us giving full details and we will help you. *Catalog on request.*

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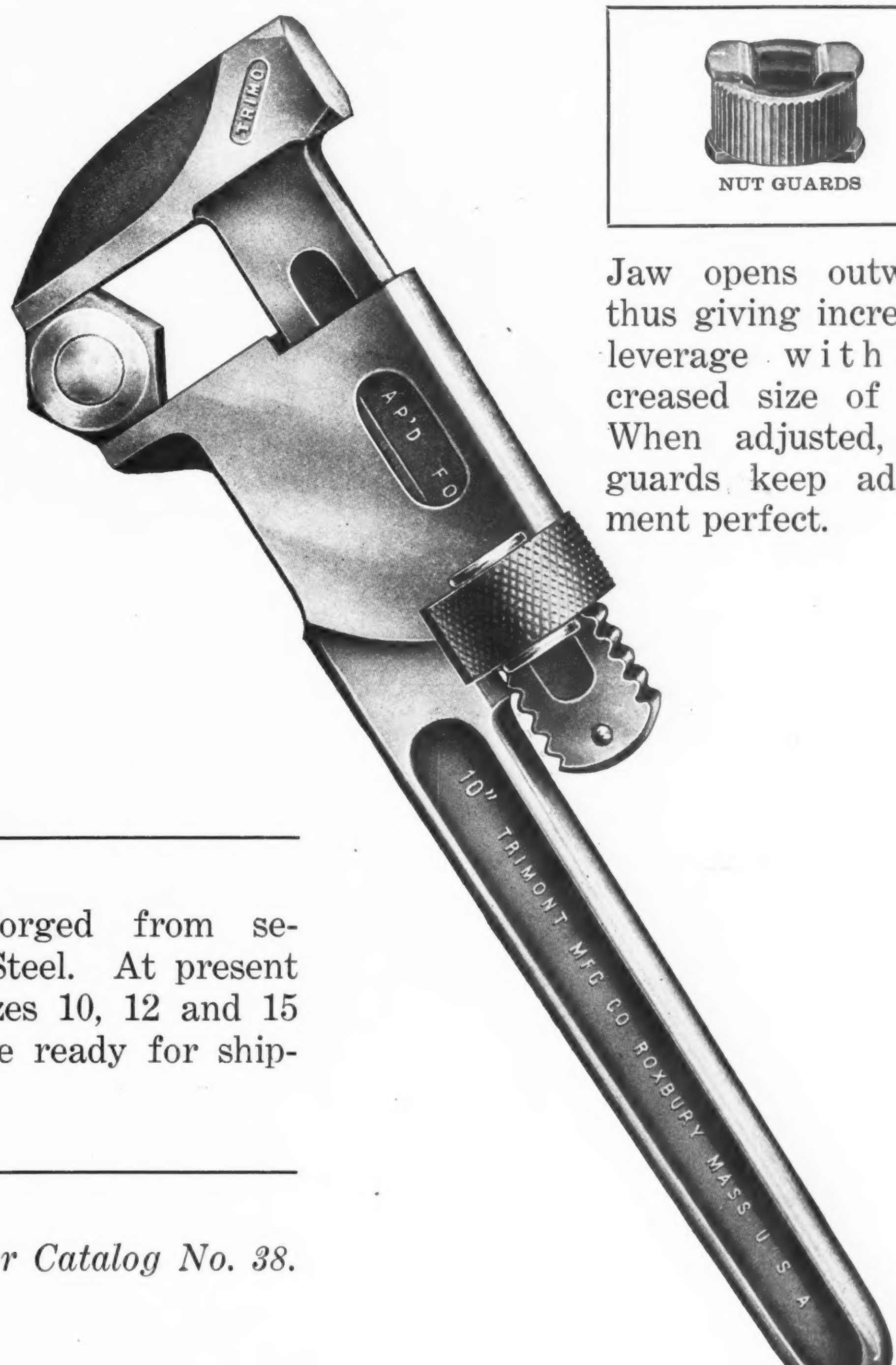
NEW TRIMO MONKEY WRENCH



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Jaw opens outward, thus giving increased leverage with increased size of nut. When adjusted, nut guards keep adjustment perfect.

Drop-forged from selected Steel. At present only sizes 10, 12 and 15 inch are ready for shipment.

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WESTERN TOOL & MFG. CO.
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"Little David" Calker.

"Little David" Riveter.

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"Little David" with Safety Retainer.

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FOR THE

Boiler Maker—Machinist—Foundryman—Iron Worker

"Crown" Floor Rammer.

The Ingersoll-Rand pneumatic tool line is the most extensive offered the trade, and covers all the requirements of the railroad shop, the boiler shop, machine shop, foundry and iron work.

It comprises such well-known tools as the "Little David" Drills, Calkers, Riveters and Chippers, "Imperial" Hoists and "Crown" Rammers.

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In designing these tools, such factors as ease of operation, large work capacity and adaptability, low maintenance and air consumption have been so well provided for, that many plants, including some of the very largest, have standardized on them.

They are built as well as it is possible to do so. Metals of quality are used throughout; wearing parts are of hardened and ground special alloy steels, and special oil treatment of metals results in a product of exceptional lasting qualities.

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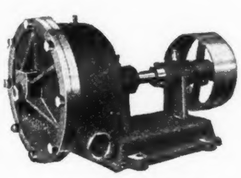

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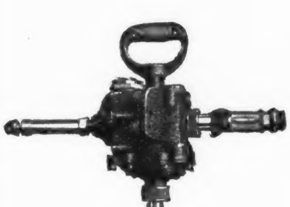
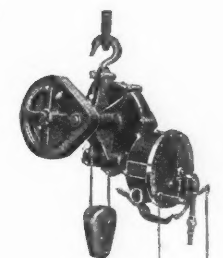


"Little David" Wood Boring Drill.



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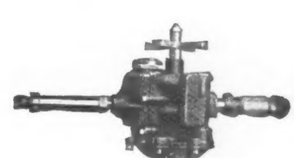

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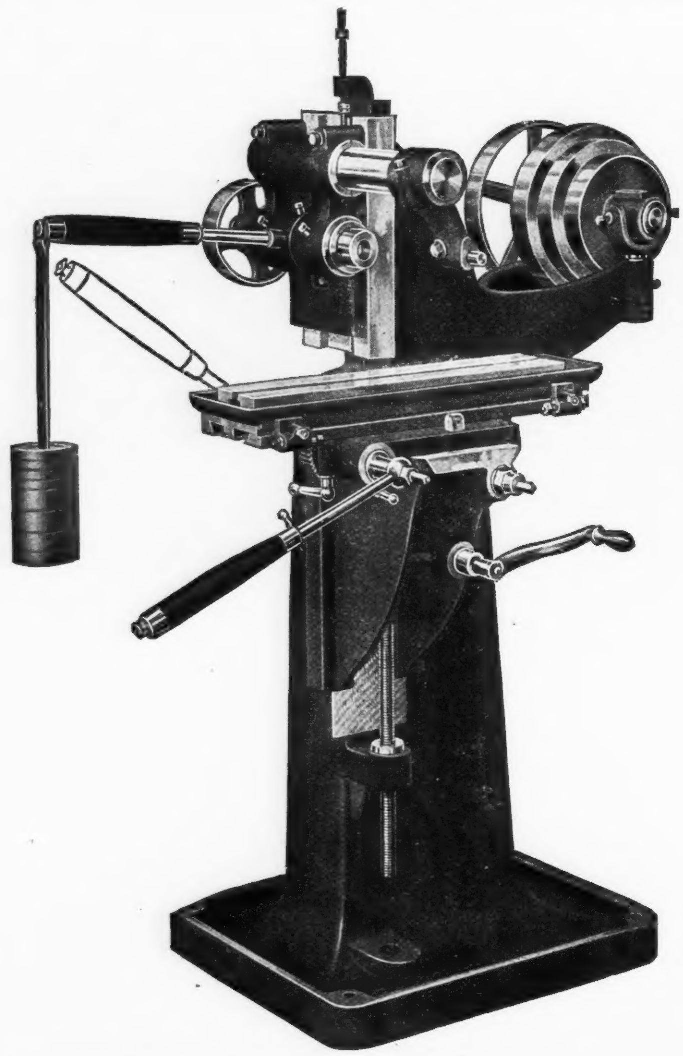

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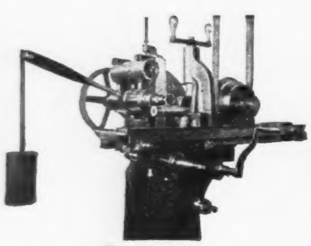
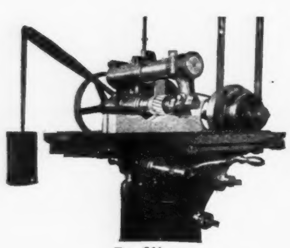
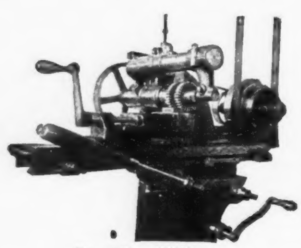


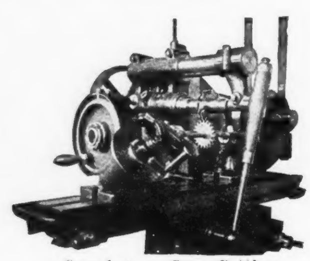
Keyseating



Profiling



Straddle Milling



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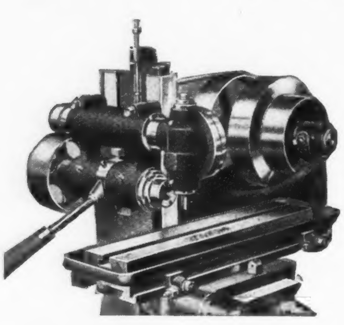

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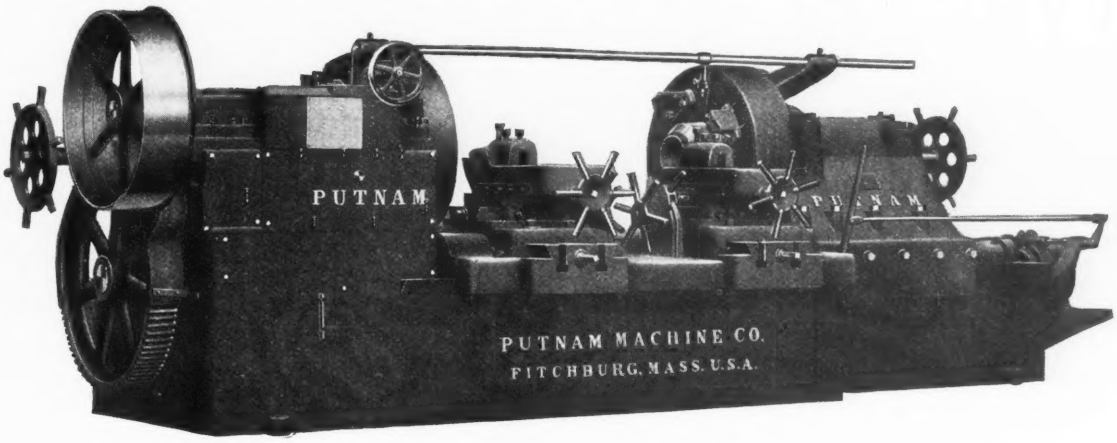

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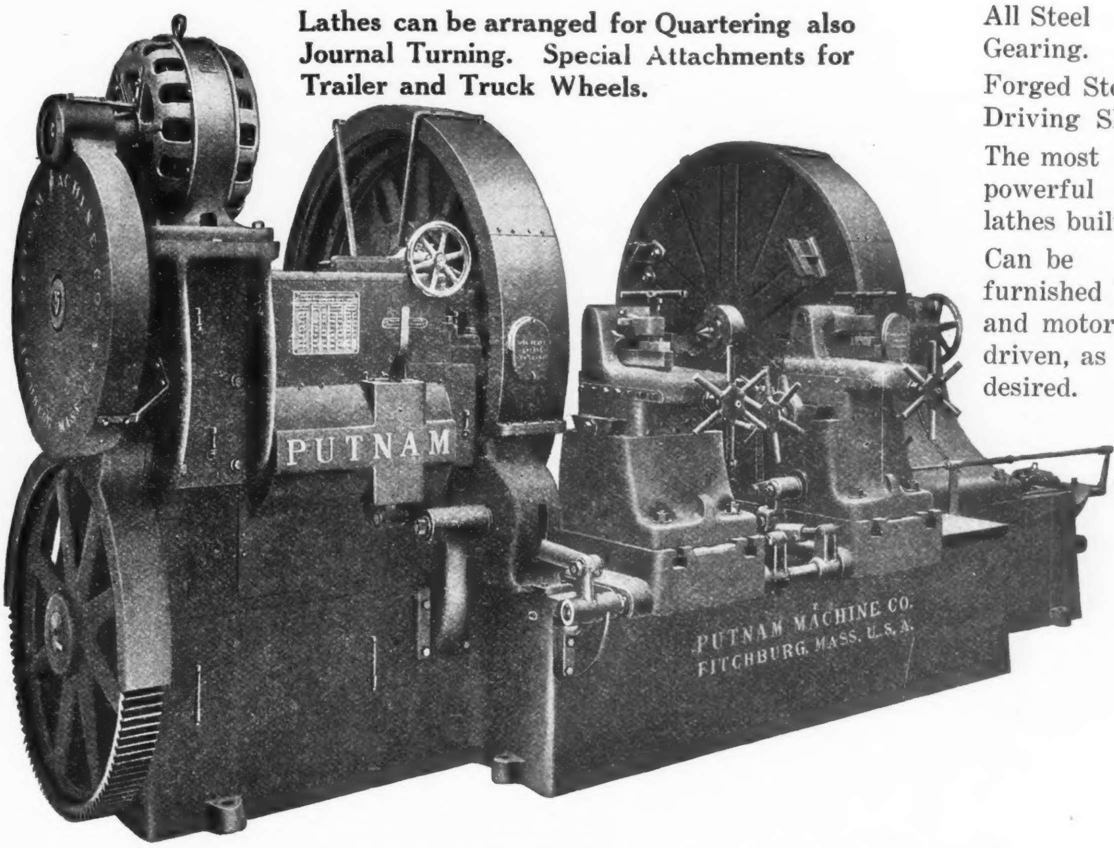

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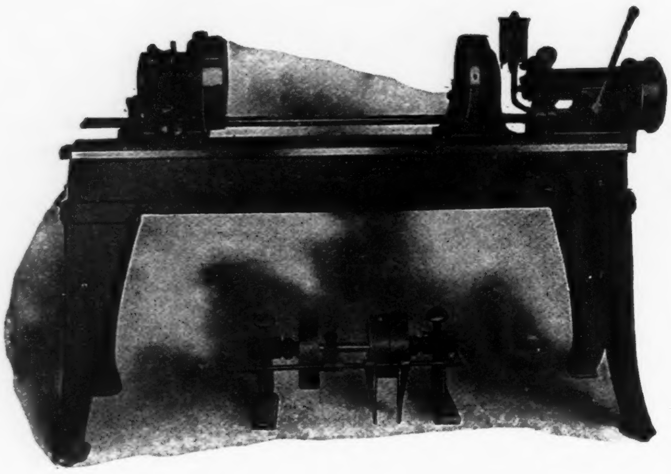

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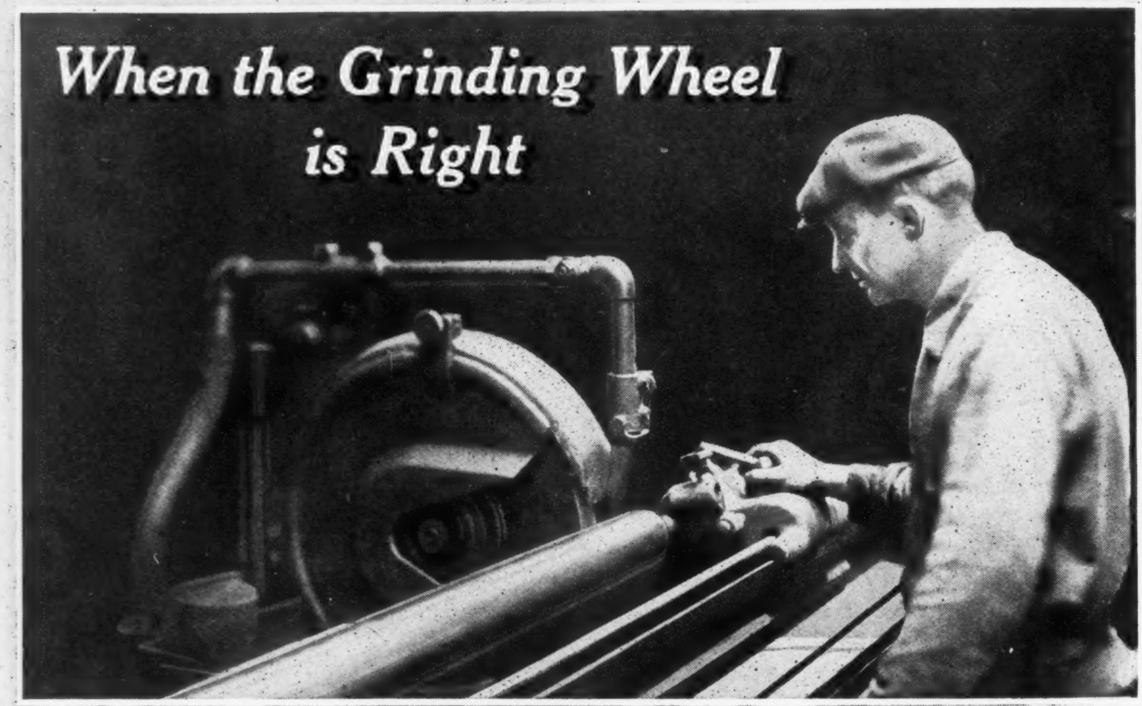

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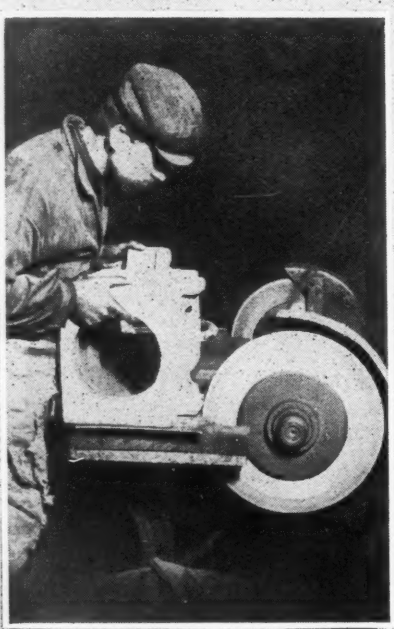

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that Every Machine Designer Should Know

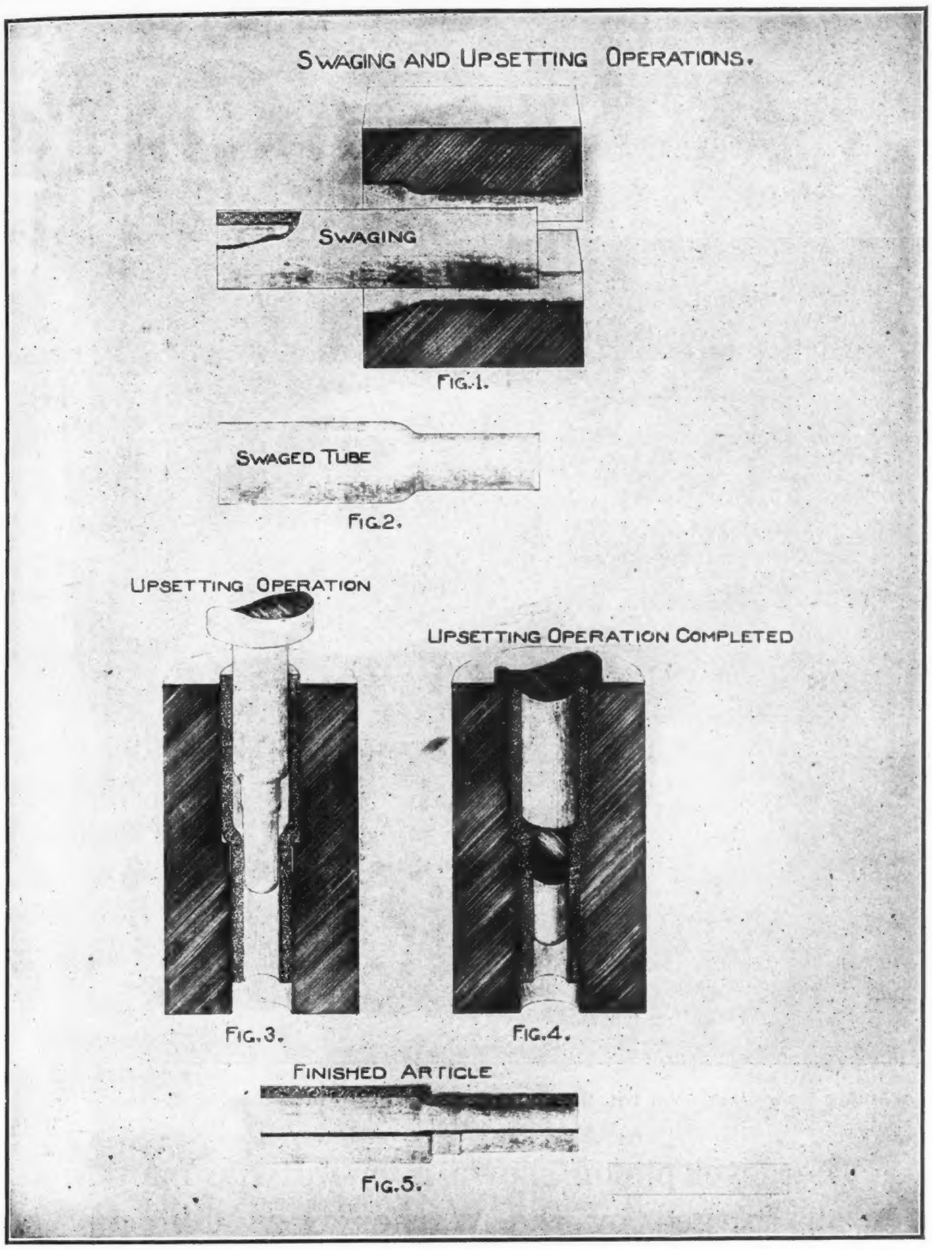

PLATE NO. 4

¶ Figure 7 (Plate 2) shows another hammering or swaging operation in a set of dies, in which the ball is rounded up so as to conform to the shape required in the finished article, figure 8 (Plate 2).

¶ Plate No. 4 shows another variation of upsetting and swaging. Here, however, the operations are reversed. The swaging, or reducing of the diameter of a portion of the tube, is done before the upsetting. The tube has three different diameters, which have to be produced with different wall thicknesses, and the most economical method of producing intricate articles is always adopted. The swaging operation, with the subsequent operation of upsetting, brings out in sharp contours the shape required in the finished article.

¶ As previously indicated, this series is designed particularly for the busy man—the illustrations suggesting (at a glance perhaps) new possibilities for Shelby Seamless Steel Tubing in machine design.

¶ Next month the operation of the spinning machine will be illustrated, and also the flow of metal during the spinning operation.

*No. 1—Facts About Shelby Seamless Steel Tubing that Every Machine Designer Should Know. (Published May, pages 152-153.)
No. 2—Mechanical Manipulations of Shelby Seamless Steel Tubing. (Published June, pages 110-111.)
No. 3—Mechanical Manipulations of Shelby Seamless Steel Tubing—Flanging. (Published July, pages 166-167.)
No. 4—Mechanical Manipulations of Shelby Seamless Steel Tubing—Forging. (Published August, pages 146-147.)

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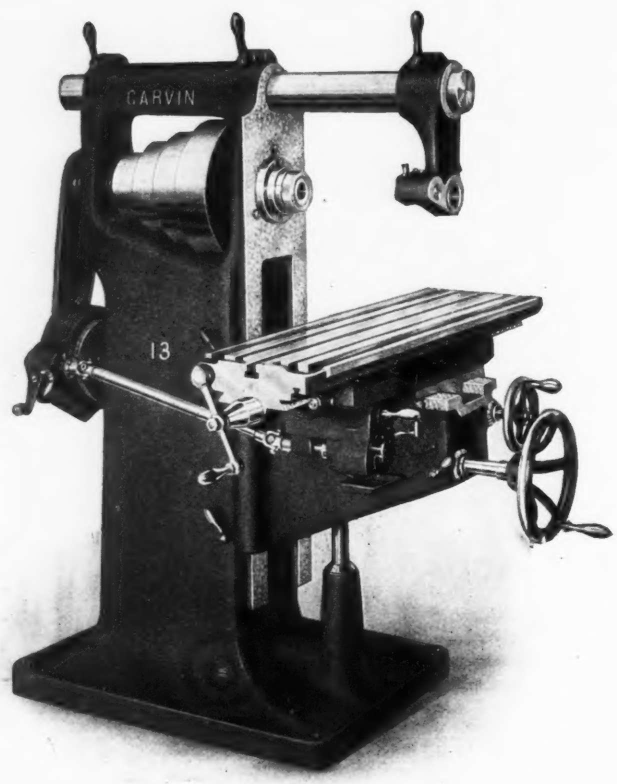

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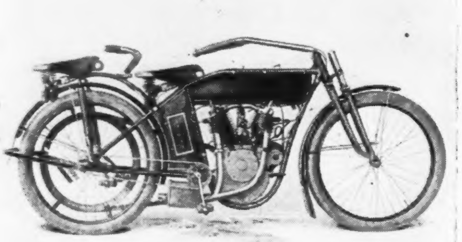

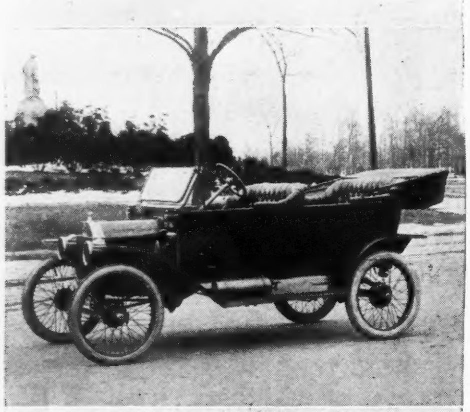

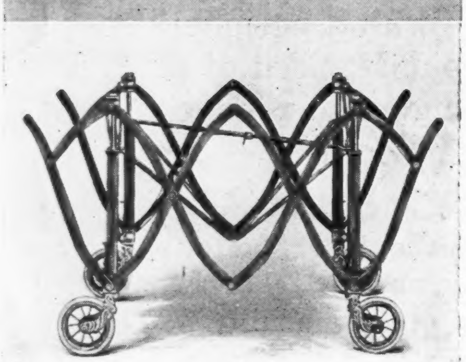

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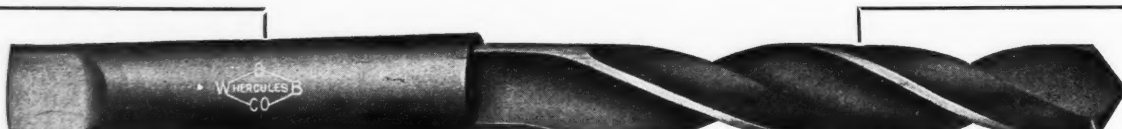

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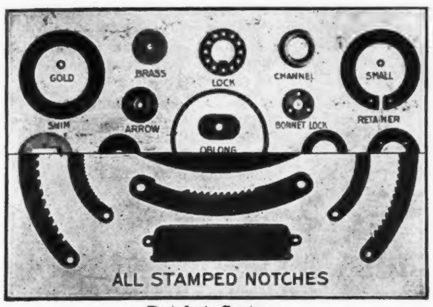

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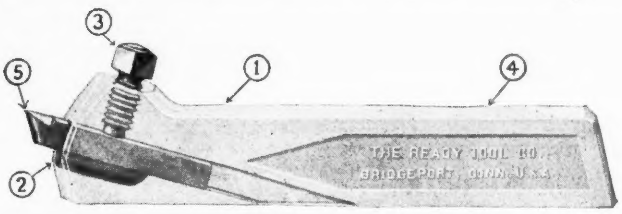

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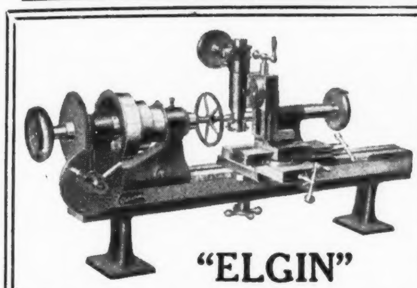

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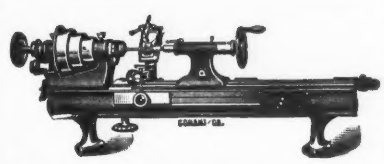

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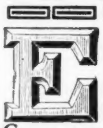

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For getting a job done on time, and satisfactorily, a "Star" Engine Lathe is unsurpassed. Light duplicate parts can be turned economically, every adjustment for close accuracy and rapidity in operation is easily made, and all operating levers are placed within easy reach of the operator.

The price of "Star" Lathes is very low. We build them in quantities, in plain finish and on simple lines.

You'll find "Star" Lathes best suited for general tool-room and manufacturing work.

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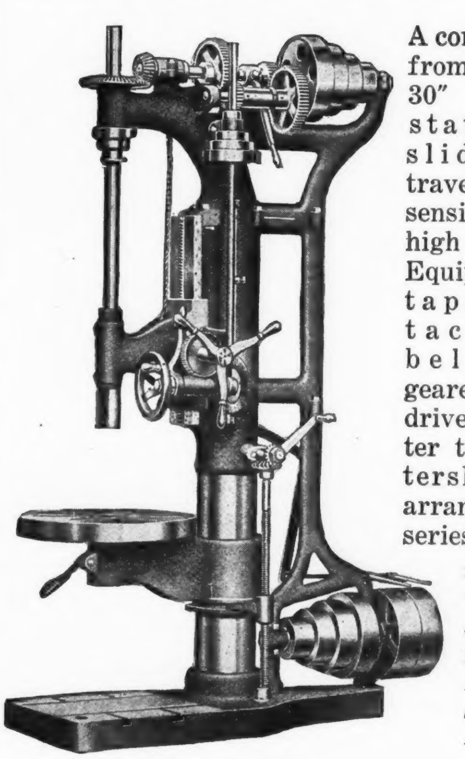

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Equipped with Hess-Bright Ball Bearings throughout

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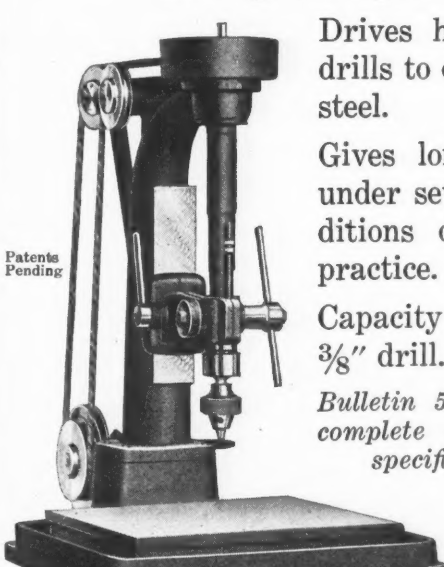

Drives high-speed drills to capacity of steel.

Gives long service under severest conditions of modern practice.

Capacity of chuck, 3/8" drill.

Bulletin 502 contains complete details and specifications.

Send for it now.

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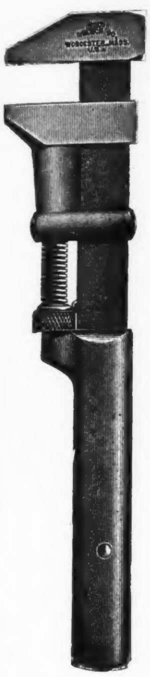

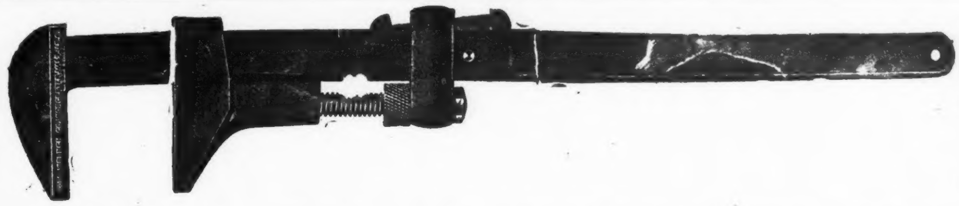

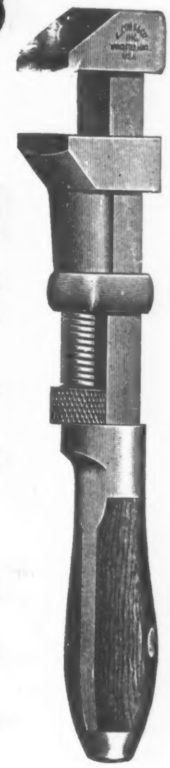

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"Coes" Genuine Wrenches have held front place for more than seventy years—in spite of the sharpest competition and the most persistent imitation.

Stronger than other wrenches, they are more efficient—made in a wide range of sizes, they are more adaptable to requirements.

Simplest in design and construction, they stand hard usage and hold their own under all conditions.

Three Styles in "Coes"

The Knife Handle "Coes" for general utility 6" to 21" sizes—hard-wood handle, head and bar in one piece.

The All Steel "Coes," for extra hard service—construction, steam, water 4" to 21" sizes.

The Key Model "Coes," for the engine room and railroad plant—the largest of the "Coes" wrenches—28", 36", 48" and 72" sizes.

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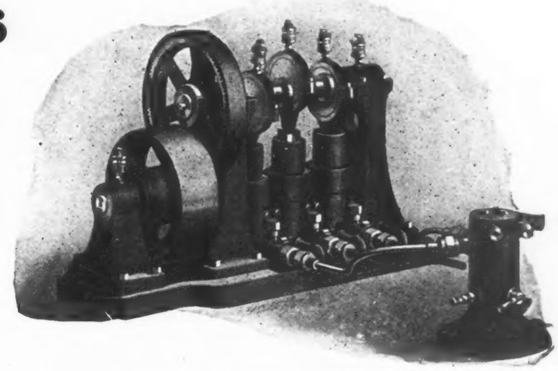

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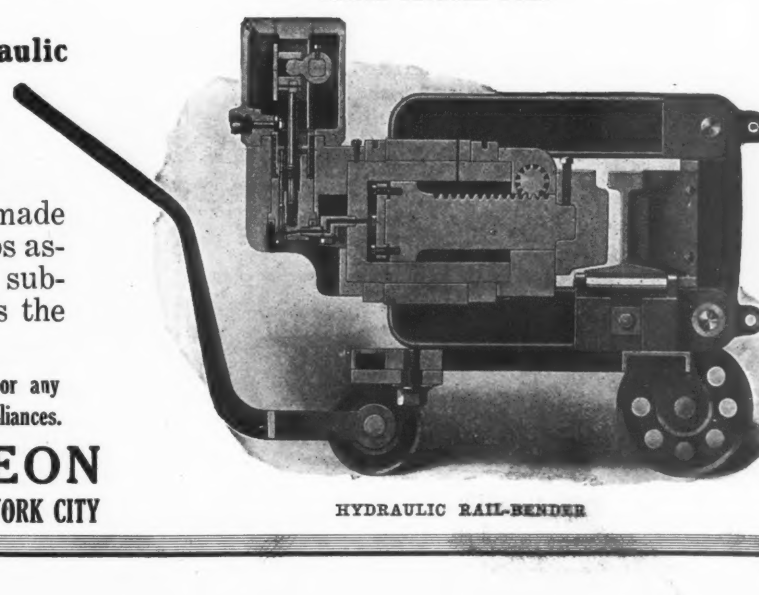
The "Dudgeon" Universal Hydraulic Girder and Rail-bender is so constructed that the ram can be run against the work by a rack and pinion; the first stroke is therefore made under pressure. Double pumps assure rapid operation, and a substantial clamping device holds the work firmly.



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If heavy castings must be lifted, materials bent or any hydraulic force employed, use "Dudgeon" appliances.

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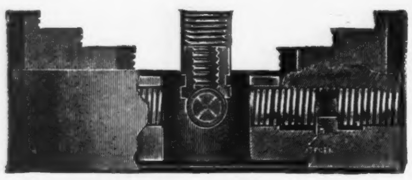

Solid Steel Rings Reenforce these Independent Lathe Chucks

making them strong where other chucks are weak, providing for tensile stresses and screw thrusts, insuring greater durability and better service.

"National" Round Body Drill Chuck

Made with three distinct grips which can be applied at the same time when necessary—a positive gripping chuck—all sizes up to 2 inches.

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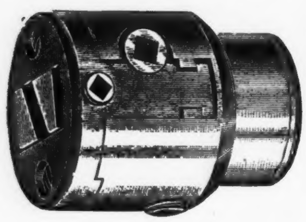

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ONEIDA, N. Y., U. S. A.

Power

Is your Engine or Motor developing its full power? You don't know unless you know the speed you are attaining.

Why not determine this by taking readings occasionally with the

Veeder Speed Counter

PRICE $3.00 EACH
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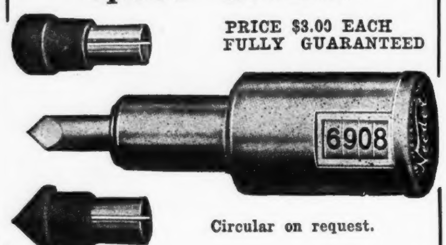

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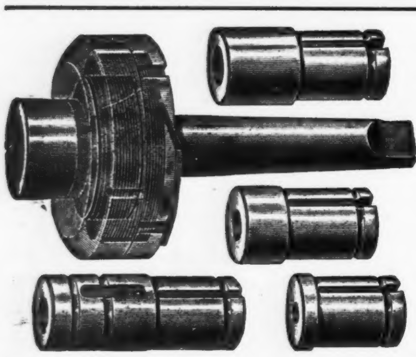

The Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction and is

UNEQUALED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to break or get out of order. Made in 4 sizes, covering from 0 to 2½ in. diameter.

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COIT Chucks

No key, no complicated mechanism. A twist of the wrist loosens or tightens the jaws of a Coit. Send for one now.

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1874 TRUMP DRILL CHUCKS 1914

Illustrated list for the asking.

40 years unbroken experience means something; that's why the TRUMP is so good a Chuck. Hold Straight or Taper Shank Drills. 3 Sizes:

No. 1	No. 2	No. 3
0 to 1/8"	0 to 1/4"	0 to 3/8"

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Send for our new catalogue and learn how to save money on Turning Tools.

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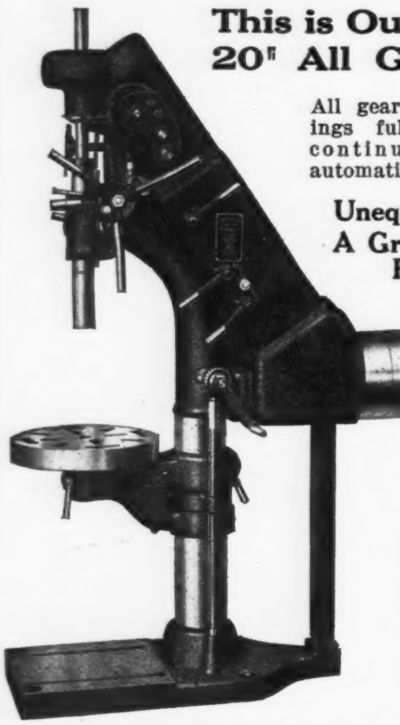

This is Our Self-oiling 20" All Geared Drill

All gears and their bearings fully enclosed and continuously lubricated automatically.

Unequaled Efficiency
A Great Machine for Factory Use

Its virtues are:

EXTREME RIGIDITY, DURABILITY, ACCURACY, HIGH POWER, HIGH SPEED, AND MULTIPLIER OF OUTPUT.

One customer says: "It is doing more work than any three other drills in our shops."

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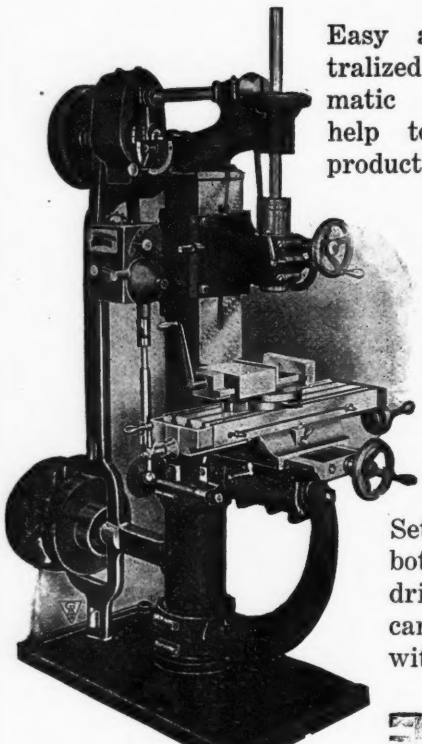
Save the Minutes



Easy adjustments, centralized controls, automatic mechanisms, all help to save time on production.

The Knight No. 2 Milling and Drilling Machine

has every operating convenience. Set the piece and both milling and drilling operations can be accomplished without resetting.

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Machinery Finishing Paints

These paints should be used when it is desired to stripe. They should be thinned with Glidden's Machinery Reducer or turpentine. They dry without luster in thirty minutes, when the machine may be striped and varnished. Any shade made to order. Put up in Barrels, one-half Barrels, 100 pound Kegs and 25 pound Cans.

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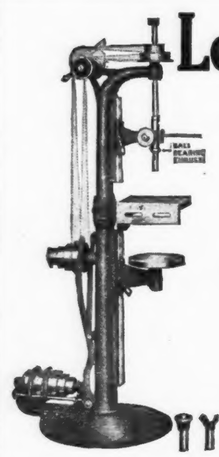

A SENSITIVE DRILL WITH SIX SPINDLE SPEEDS FROM 600 TO 2400.

Ample power for ½" drill; right speed for smallest drill.

Net Price Only $50.00

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TURNER TURRET

New Model "C"—a heavy, flexible turret machine, built to handle heavy-duty work quickly. Range is wide, accuracy assured, reliability guaranteed—the machine that meets all your needs. *Descriptive catalogue if you'll ask for it.*

TURNER MACHINE COMPANY

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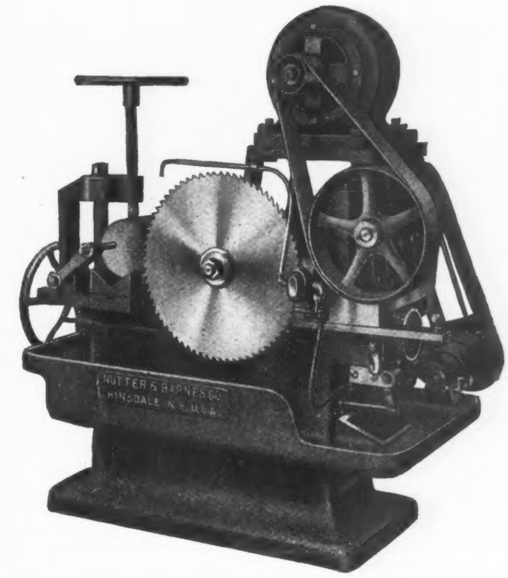
Nutter & Barnes Machines
For Greater Metal Cutting-off Efficiency

For greater efficiency, more economical metal cutting, you need Nutter & Barnes Machines—an Automatic Cutting-off Machine to drive a saw at its highest efficiency, and a Saw, Gear and Cutter Sharpener to keep the saw in perfect condition and to care for other cutters.

Nutter & Barnes Metal Cutting-off Machines

have the widest range—size of saw considered—of any machines on the market. They are rigid, accurate machines, safe to operate and convenient. Several sizes for varying conditions.



The Saw, Gear and Cutter Sharpener

is a necessity in practically every tool-room. Let us tell you about it. Send for the new complete catalogue—a Treatise on Cutting Metals.

NUTTER & BARNES COMPANY

The Metal Cutting-off Machinery Specialists

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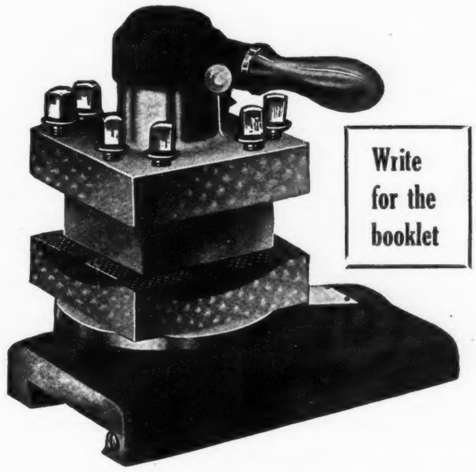
Four Tools Always Ready

For the job requiring the use of two or more cuttings tools, the

F & S SELECTIVE TOOL POST

is unsurpassed. From one to four tools can be clamped securely in this Tool Post and brought into instant action by moving the index handle.



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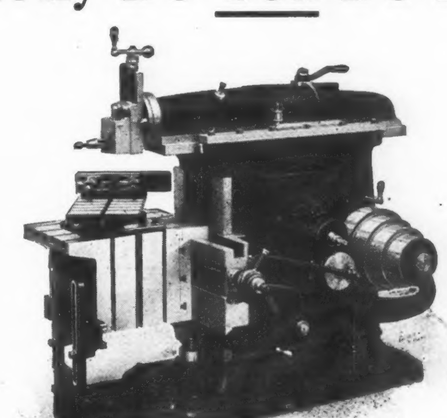
FAY & SCOTT, Dexter, Maine

Why Do You Do It?



Heat treat those parts of your machines that are subject to extra heavy duty and wear, and make oiling of all important bearings certain.

Machine Tools with soft journals and squirt-can methods of oiling are behind the times.

The question is, "Are you going to buy these back numbers or the Queen City?" No amount of talking points are as important as the above features. Investigate before you buy.

Queen City Shaper Company

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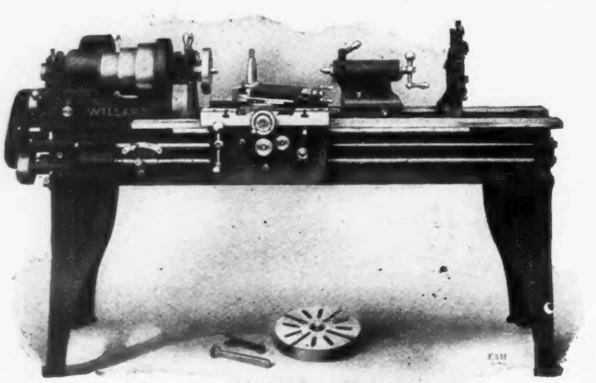
FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry; W. Steinhaus & Co., Bruxelles and Paris; F. G. Kretschmer & Co., Frankfurt, a/M. Allied Mchy. Co. of America, Turin.

FULL SWING
SIDE CARRIAGE TURRET LATHES

STEINLE TURRET MACHINE COMPANY
MADISON, WISCONSIN, U. S. A.



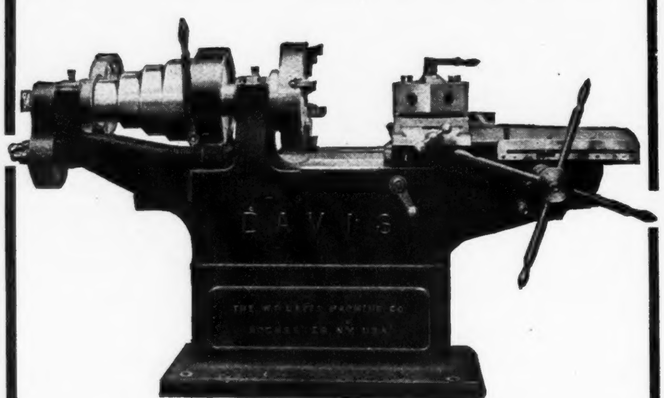
Plenty of Power in a Willard Engine Lathe

No matter how tough the job, a "Willard" will turn it. Willard 13" Engine Lathes have four feed changes secured by one lever, the gears are quickly meshed for the right speed and a safety device prevents two feeds being thrown in at once.

Willard Lathes take up little floor space, are efficient, convenient, adaptable and accurate to the finest degree. Cabinet Leg model also.

Details?

The Willard Machine & Tool Co.
Cincinnati, Ohio, U. S. A.



WIDE RANGE—EASY CHANGE

The exceptionally wide range of the Davis 24" Turret Lathes, combined with quick-change features, provides a lathe which has few equals. The extra heavy bed, cast in one piece, eliminates vibration and assures rigidity. Now fitted with automatic independent stops for each face of turret. *Ask for latest bulletin and circular of other Davis machines.*

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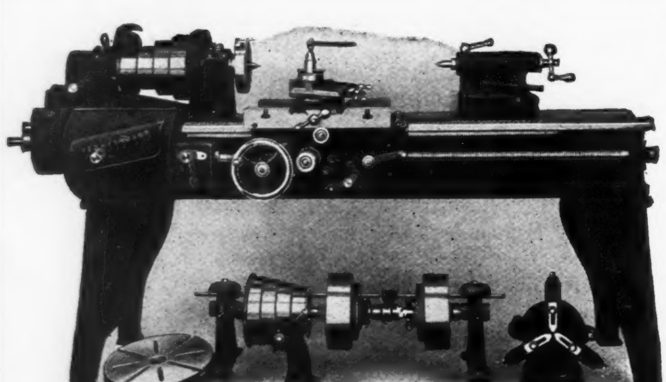


Read Our Specifications

Before going ahead get a copy of our specifications of this 14" engine lathe. It's a

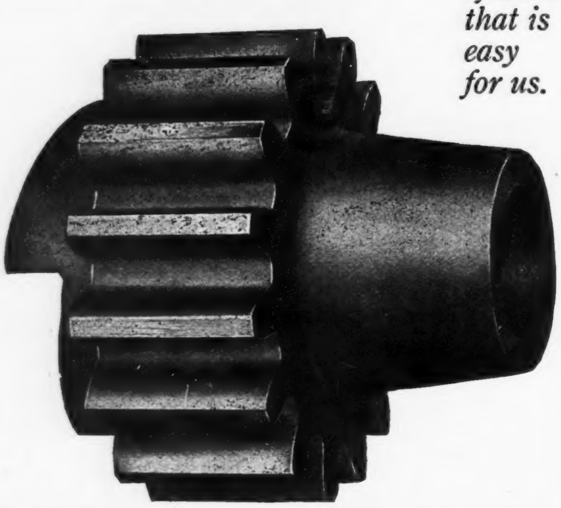
Carroll-Jamieson Screw Cutting Lathe

It has double back gears, quick-change gears giving thirty-two changes of feed without removing a gear, nine spindle speeds, 2½" belt drive from three-step cone.

Drop a line now for a set of specifications.

The Carroll-Jamieson Machine Tool Company
257 Davis Street Batavia, Ohio

Clutch Gears. A kind of work that is easy for us.



"Any Old Gear" WON'T DO Everywhere, but New Process Gears and Pinions WILL

You get more than mere material and machine work when you buy New Process Gears and Pinions. You get correct tooth design, right machining methods, judicious selection of metal and the careful finish essential to permanently satisfactory service.

One order would prove to you that New Process Gears and Pinions are reasonable in price and genuinely good.

Send your prints or specifications for figures.

N.P.R.H. Co. REG. U.S. PAT. OFF.

YOU CAN'T PUT YOUR GEAR WORK INTO BETTER HANDS

NEW PROCESS GEAR CORPORATION

SYRACUSE, N. Y.

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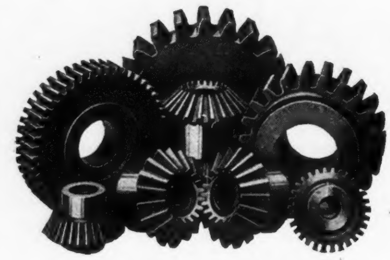


Nuttall Small Cut Gears

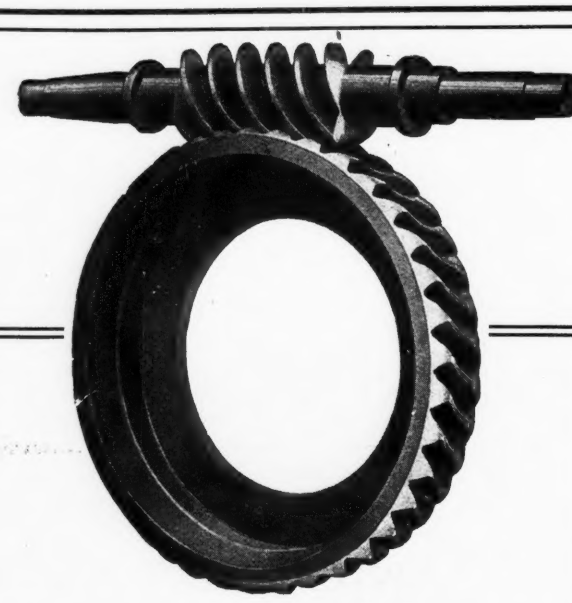
Our plant is not only equipped to cut the largest gears built, but also those of the smaller sizes.

Gear Cutting has been our business for more than a quarter of a century. We can furnish gears to your specification.

Address Dept. K.

Nuttall — Pittsburgh

World's Largest Gear Works



Cleveland Worms

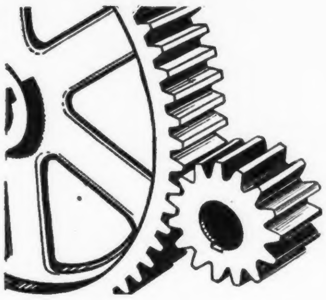
are being successfully used by many for automobile and heavy stationary drives. Information gladly given.

Why Experiment with Experimenters?

The Cleveland Worm & Gear Co.

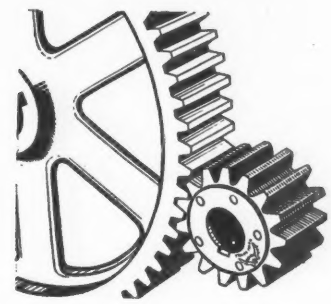
988-992 E. 67th St., Cleveland, Ohio, U.S.A.

GOOD BETTER BEST



An accurately machined steel pinion meshing with an accurately machined gear is tolerably quiet when new-that is, providing the shaft alignment is perfect.

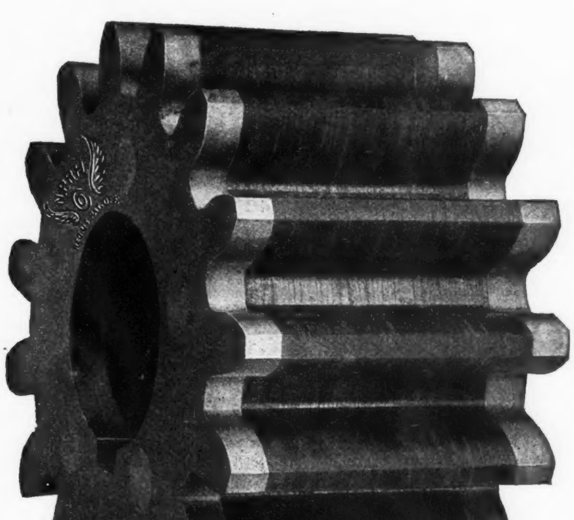
And a generous supply of oil continually poured onto the gears will decrease the noise. But after the gears are worn no amount of oil will quiet them.



A New Process pinion meshing with its mate is always quiet regardless of age and wear of either gear. No oil. No noise. No trouble. A comfort to your men.

Ordinary engineering experience must tell you that machine parts last longer where vibration is minimized—that metal-to-rawhide tooth contacts offer real protection from gear breakage under sudden load imposition.

Considering also that rawhide pinions, as made by us, are as durable as metal, and that the relief you get from distracting noises really costs nothing, the wisdom of using New Process Pinions is readily apparent.



Let us submit evidence of what New Process Pinions are doing under conditions similar to your own. Ask for book—"Noiseless Gear Driving."

N.P.R.H. C REG. U.S. PAT. OFF.

NEW PROCESS IS TO ALL OTHER RAWHIDE AS STEEL IS TO IRON

NEW PROCESS GEAR CORPORATION
SYRACUSE, N. Y.

Canadian Agents:
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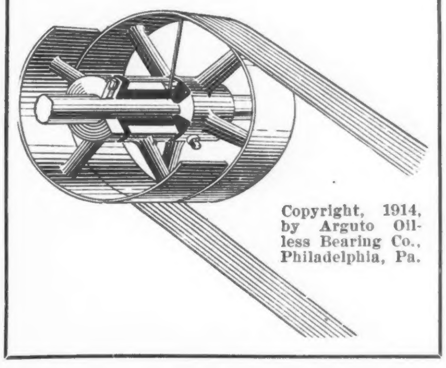
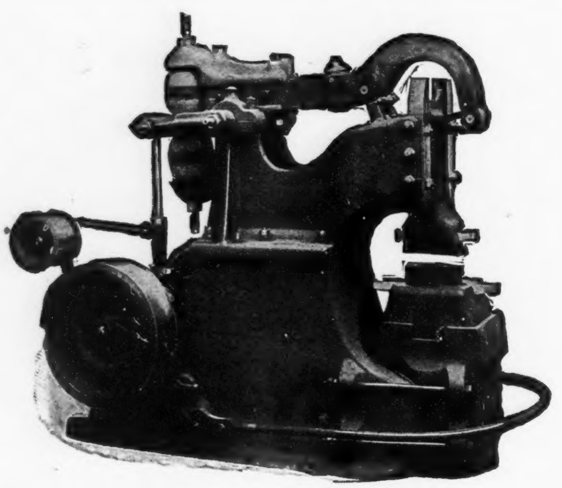
STYLE A





Bradley Upright Hammers

Are made with heads weighing 15 to 500 pounds. Each contains one-third to one-half more material than those of any other make of the same rating.

Their anvil blocks weigh nearly or quite double those of other hammers.

Their output is guaranteed 25 per cent greater than is possible with other hammers of same rating or no sale.

More Bradley Hammers are sold each year than all other power hammers combined.

WE MAKE

The Bradley Cushioned Helve Hammer **The Bradley Upright Helve Hammer**
The Bradley Upright Strap Hammer **The Bradley Compact Hammer**
Forges for Hard Coal or Coke

SEND FOR CIRCULARS

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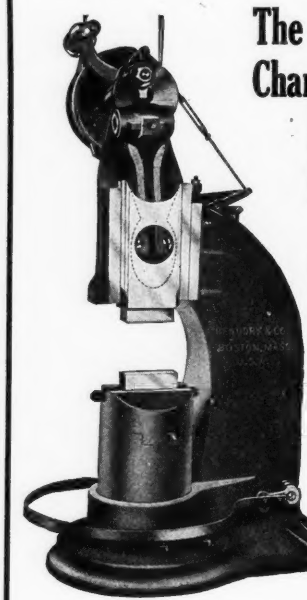
FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Buck & Hickman, Whitechapel Road, London.

The Beaudry Champion Power Hammer



Simple
Durable
Efficient
Economical

Adapted for every description of forging

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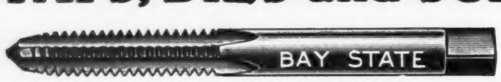
TAPS, DIES and SCREW PLATES



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BAY STATE TAP & DIE COMPANY, Mansfield, Mass.

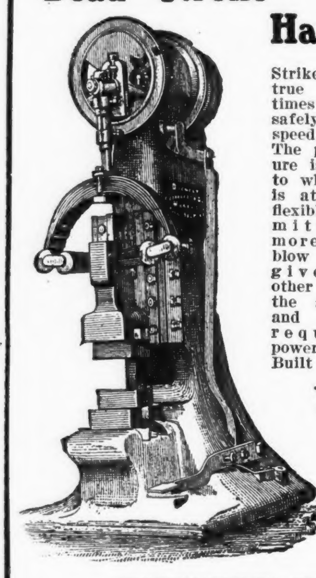
CHAMBERSBURG STEAM HAMMERS

"ALL SIZES FOR EVERY CLASS OF WORK"

Our hammers are double acting, have simple valve gear and give the operator perfect control. *Write us for details.*

CHAMBERSBURG ENGINEERING COMPANY, Chambersburg, Pa.
HYDRAULIC MACHINERY

"Dead Stroke" Power Hammers



Strike a square, true blow at all times and can be safely run at high speed.
The peculiar feature is the spring, to which the ram is attached by a flexible belt, permitting a far more effective blow than can be given by any other hammer of the same weight and stroke, and requiring less power.
Built in 7 sizes.

Write for circulars.

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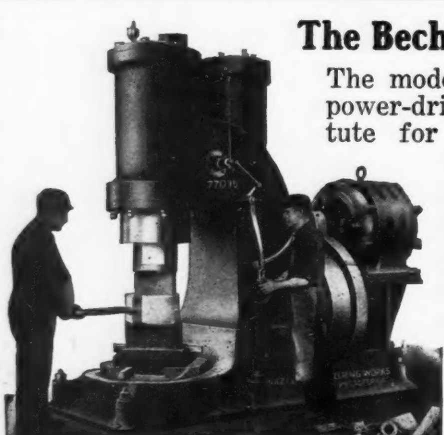
1304 No. Howard Street
PHILADELPHIA, PA., U. S. A.



The Beche Hammer

The modern, reliable power-driven substitute for the steam hammer.

Nazel Engineering and Machine Works
4043 N. 5th Street
Philadelphia, Pa.

Built in six sizes to work efficiently from 2" to 9" square. Belt or Motor Drive.

WRITE FOR CATALOGUE.

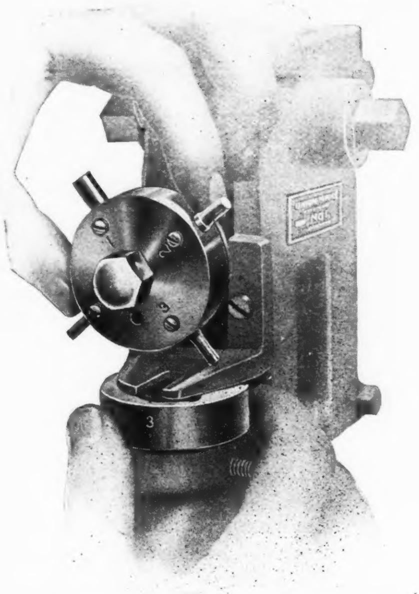
The HIGLEY

COLD METAL SAW

Catalog furnished by

Vandyck Churchill Co.
New York Philadelphia Pittsburgh New Haven

THE UNION Combined Punch, Shear and Rod Cutting Machine



The Turret Punch and showing method of changing from one size to another

The TURRET PUNCH on this machine consists of *four different sizes of punches* and four corresponding dies. It is easily operated and always ready for work.

With this handy machine you can punch four sizes of holes, you can cut off rods, or shear off stock up to the capacity of the machine. It has also been used for cutting angles, channels, etc.

Let us show you how it can be adapted to your work.

No. 2 size mounted on legs

UNION MANUFACTURING COMPANY

New York Office:
26 Cortlandt Street

NEW BRITAIN, CONN., U. S. A.

COMPLETE HYDRAULIC EQUIPMENT

The illustration shows one of our complete hydraulic die press outfits. The press is connected to a motor driven four-plunger pump. The single operating lever shown beneath the gauge, controls the entire operation of the press. This is but one of the outfits we can furnish. We build all kinds and sizes of hydraulic machinery, and everything necessary to the complete installation, including pump, accumulators, intensifiers, valves, hydraulic pipe and fittings, and all sizes of leather packings of a quality unequaled by any other now on the market. **Write for catalogs.**

The Watson-Stillman Co.

ENGINEERS AND BUILDERS OF HYDRAULIC TOOLS

192 Fulton St. **New York**

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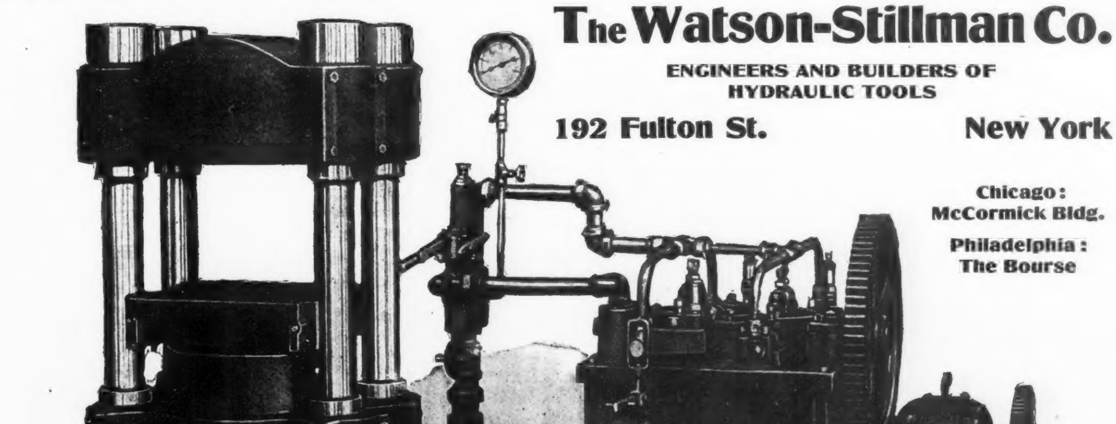
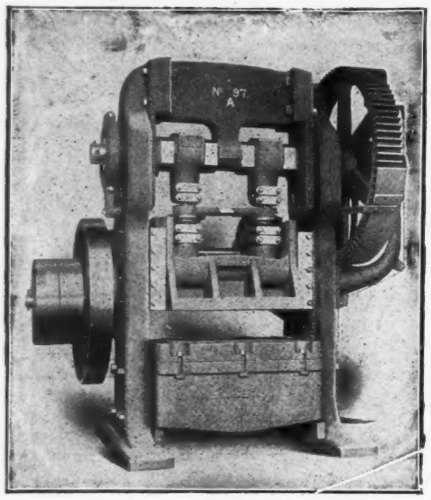


231

Whatever the business conditions, you can improve the condition of your business by installing



"TOLEDO" Presses

No. 97-A—A powerful "Toledo" 60" Double Crank Press designed for heavy cutting, gang perforating and forming light or heavy stamped steel parts, such as armature segments, steel wheels, floor registers, heater parts, automobile frames, etc.

Weight about 85,000 pounds.

Built single or double geared.

Presses and Dies for every requirement

The Toledo Machine & Tool Co.

Toledo, Ohio, U. S. A.

DIXON'S

Graphite Cup Grease

This line is made in a wide variety of grades—uniform as to quality, but differing in hardness for various classes of service.

Only the finest of mineral oils are used, with their lubricating qualities made more lasting and effective by the admixture of the right proportions of Dixon's fine flake graphite.

They never turn rancid or gum up—are not greatly affected by changes of temperature—the graphite veneer built up on the bearings may be depended upon to give perfect lubrication at all times and under all conditions.

Dixon's Graphite Greases need no special handling—they can be used in ordinary grease cups or in open bearings.

If you are not sure just what grade of Dixon's you need for your work, write us as to the service involved and we will recommend the proper grease—will send you a trial sample if you wish.

Send for Booklet No. 74 on "Graphite Cup Greases."

Made in JERSEY CITY, N. J., by the

Joseph Dixon Crucible Company

Established 1827

TWENTIETH CENTURY BALANCING TOOL

Always level and ready for use, no matter where or how you place it.

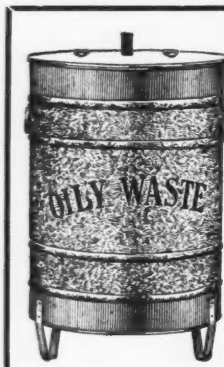
A practical tool for balancing pulleys, cones, armatures, polishing wheels, etc.; requiring no leveling or adjusting, it embodies great labor-saving features. No machine shop or polishing room can afford to be without this tool.

Made in four sizes to swing from 22" to 8-ft.

Write for descriptive circular.

MANUFACTURED BY

ROCKFORD TOOL COMPANY, Rockford, Ill.



Storage Cans for Waste and Oil

The Delphos Oily Waste Can keeps oil-soaked waste out of harm's way and promotes order and cleanliness.

The Delphos Non-overflowing Oil Dispenser pumps any kind of oil, cannot overfill and is the quickest, cleanest and best method for filling the shop oil cans. Circulars on request.

For safety and economy use Delphos Cans.

DELPHOS MFG. CO., Delphos, Ohio, U. S. A.

NOT IN A TRUST

HAYES FILE COMPANY, Detroit, Michigan

Use our SPECIAL SOLDER-CUT File, for filing Solder

FLEXIBLE STEEL TUBING

CONTAINS NO PACKING

SEND FOR DETAILS

FOR SUPPLYING LUBRICANT TO MACHINE TOOL CUTTERS

WHEELOCK MFG. CO., WHEELOCK, VT.

PORTABLE TOOLS—*Cylinder Boring Bars, Flue Cleaners, etc.*

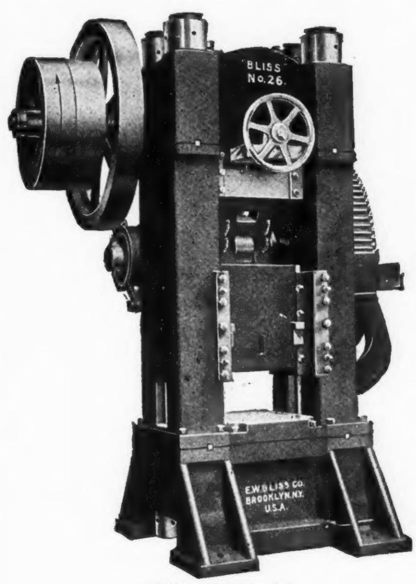
Send for Catalog

H. B. UNDERWOOD & COMPANY

1024 HAMILTON STREET - - - - PHILADELPHIA, PA.

Bliss Knuckle Joint Embossing Presses

Presses combine a massive, powerful construction with every facility for delicate adjustment.



"Bliss" No. 26
800 Tons Pressure

They have proved a high degree of economy in the embossing of steel, silver, britannia, brass, copper, aluminum, etc., in the manufacture of medals, coins, regalia, jewelry, watches, silverware, nameplates, etc.

The slides are actuated from above by means of powerful toggles made of tool steel, hardened and ground.

Easy, quick and accurate adjustments for pressure and die space are made by means of a tool steel wedge between punch holder and frame. Sometimes provided with automatic feeds, which greatly increase production.

Built in seven sizes, ranging from 100 to 1,500 tons pressure and from 7,000 to 110,000 pounds in weight.

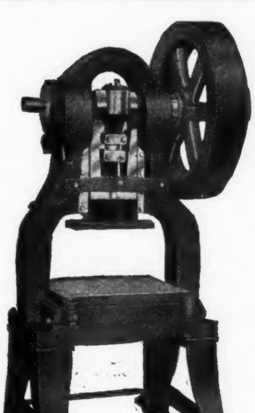
Ask for detailed description.

E. W. BLISS CO.

5 Adams Street, Brooklyn, N. Y., U. S. A.

Representatives for Chicago and vicinity: Stiles-Morse Co., 565 West Washington Street, Chicago, Ill.

Offices in Europe: 100 Boulevard Victor Hugo, St. Ouen, Paris. Pocock Street, Blackfriars Road, London, S. E.



Swaine Arch Power Presses

are constructed just right for the rapid and accurate handling of a wide variety of sheet metal products. Particular attention is directed to the ample distance between the uprights and the large opening in the bed.

SWAINE PRESSES

have provision made in their design for the use of many special attachments, including: Sunken Bolsters, Wiring Frames, Horn and Frame and similar fixtures that may be required. The Removable Front which permits the use of all these is a noteworthy feature.

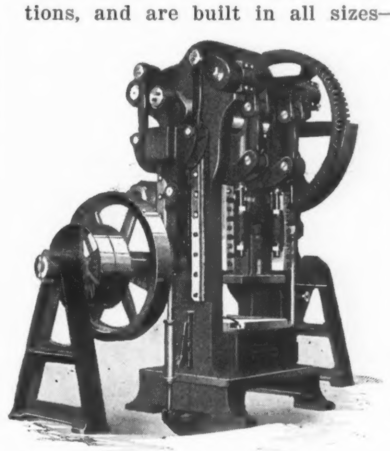
Send for our 200 page Catalogue.

FRED. J. SWAINE MFG. CO.
7th and O'Fallon Sts. St. Louis, Mo.

LARGEST PRESS BUILDERS IN THE WEST

"CLEVELAND" TOGGLE DRAWING PRESSES

Perfect dwell and perfect timing—"Cleveland" Toggle Presses are unusually heavy in their proportions, and are built in all sizes—both single and double crank, for the production of all classes of drawn sheet metal parts. They are equipped with automatic or hand operated multiple disc friction clutches. Yokes, rock shafts, cranks and links are steel castings. All pin bearings are bronze bushed.



Patent Applied For.

We are prepared to furnish complete equipments of Presses, Shears and Dies for the production of large or small sheet metal articles of every description.

Send us your inquiries.

THE CLEVELAND MACHINE & MFG. CO.
4944 Hamilton Avenue
CLEVELAND OHIO, U. S. A.

Genuine Armstrong Stocks & Dies

Are Made Not Only to Cut Pipe

BUT BOLTS AND ROD AS WELL

Users can purchase extra bolt dies and bushings which will fit the Genuine Armstrong Stock from any first-class dealer.

HINGED PIPE VISES

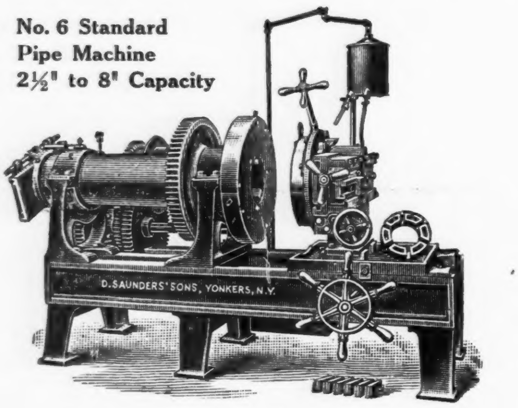
WATER, GAS & STEAM FITTERS' TOOLS

Manufactured by

THE ARMSTRONG MFG. CO., 297 Knowlton St., BRIDGEPORT, CONN.

NEW YORK CHICAGO

No. 6 Standard
Pipe Machine
2½" to 8" Capacity



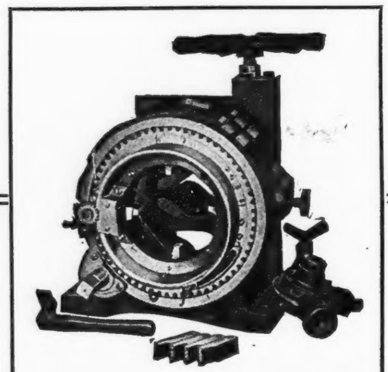
Pipe Threading and Cutting is Simplified by a "Saunders"

The simple design and strong, durable construction of Saunders Pipe Threading and Cutting Machines make them most economical to use. Plenty of power without large pulleys or tight belts; no loose gears; die head moves to one side to allow for cutting off —an exclusive "Saunders" feature which prevents injury to chasers as the pipe does not pass through die head at all. Before purchasing a pipe threading and cutting machine investigate the "Saunders."

Ask for Catalogue "P"

D. Saunders' Sons, Yonkers, N. Y.

"THE FORBES"



You Can't Afford to be Without the Forbes Patent Pipe Cutting and Threading Machine

It is the portable pipe machine with which one man can cut off and thread pipe from ¼" to 15" diameter.

It's a complete machine; no wrenches nor other accessories required. It is especially adapted for trench work; combines the speed and strength necessary for economy, and has all parts interchangeable.

For a high-grade machine at a reasonable price —see the Forbes.

Catalog No. 17 on request.

THE CURTIS & CURTIS COMPANY

8 Garden Street BRIDGEPORT, CONN.

Standard Wieland 6-inch
Pipe Threader and Cutter

Thread Pipe Do You? How?

The modern, efficient way is the Standard Wieland way, with a heavy, sturdy, durable machine, simple and positive in operation, fast and accurate in production. This machine costs more and is worth it; character and quantity of output prove it.

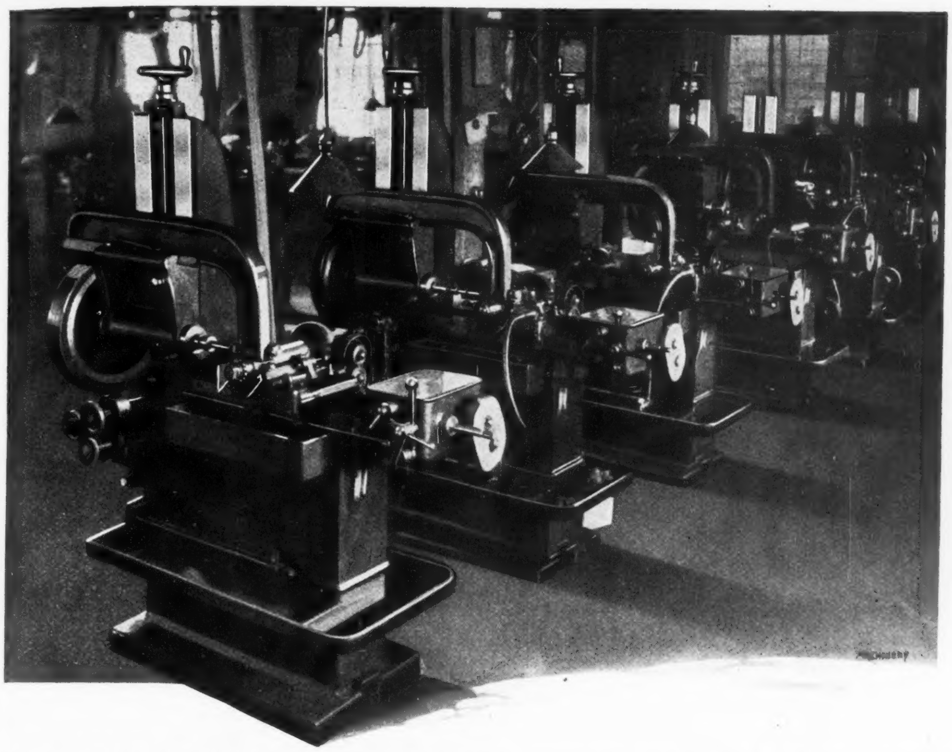
A few features: One-piece bed; single-speed pulley; gear speed changes through semi-steel cut gears; deep chasers, cutting long taper threads in one cut perfectly, steel as well as iron pipe.

Send for the circular.

Standard Engineering Company

Ellwood City Pennsylvania

San Francisco Office: 1801 Claus Spreckels Bldg.



This Installation 8 NEWARK GEAR CUTTERS

These 8 Newark Gear Cutting Machines were bought and installed one at a time by a big electrical manufacturing company—all No. 2-A Machines—all doing similar work—all making good, or they wouldn't be there.

The 2-A is the "Baby" Newark Machine; capacity 24" x 8" x 8 D. P.; entirely automatic in operation; cuts spur gears only, including sprockets, ratchet wheels, circular saws and similar work; easily set up and as efficient, profitable and accurate a gear cutting machine within its range as you'll find.

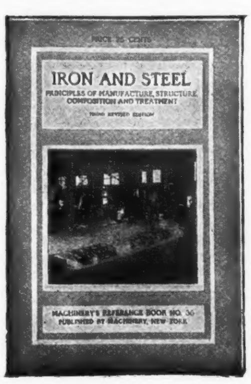
CATALOGUE SHOWS OTHER SIZES; THIS AND OTHER NEWARK TYPES

NEWARK GEAR CUTTING MACHINE CO., Newark, N. J.

CURTIS TURBINE FOR SALE

Turbine includes the following: 1 3000 Kw. General Electric, 4600 volt, three phase, four stage, 720 R. P. M. vertical turbine, including condenser base and tubes; 1 Laidlaw-Dunn-Gordon dry vacuum pump; 2 oil step bearing pumps; 1 motor-driven circulating pump; 1 Edwards steam-driven combination air and wet pump; 1 upper bearing; 1 middle bearing; 1 lower bearing, 2 or 3 step blocks; 1 atmospheric valve with connection to condenser; 1 exhaust head and as much galvanized iron piping for same as we can furnish; 1 extra valve casing, and floor plates around turbine. All apparatus in strictly first-class operating condition. Was removed from power plant to make room for an 8000 K. V. A. unit installed in its place. Can make immediate shipment and we will make a low price on quick sale.

THE EDISON ILLUMINATING COMPANY, Detroit, Mich.



Iron and Steel

One of Machinery's Reference Books which graphically describes the process of manufacture of iron and steel, from the time the iron ore is mined until it is ready for market.

The book is written from a practical and interesting standpoint, tells its story in non-technical language, but covers the subject thoroughly.

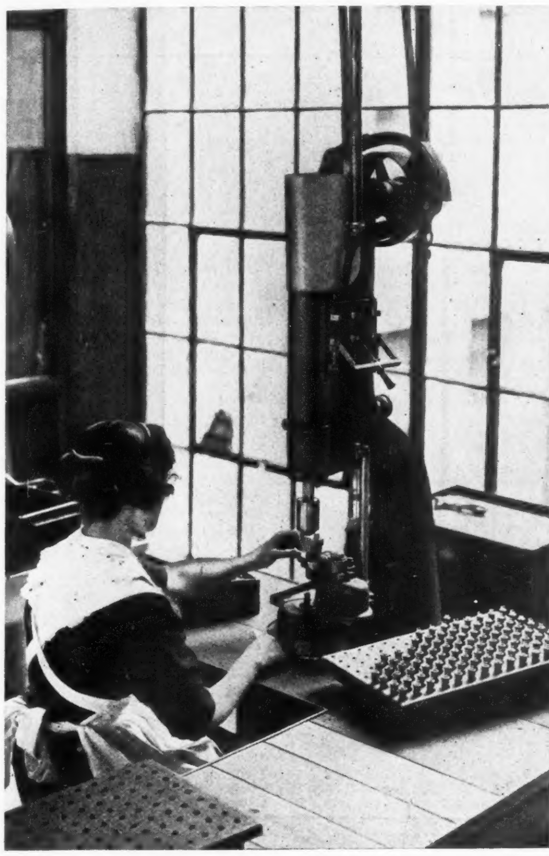
Shop Arithmetic for the Machinist

Another "Reference" book that you need. Makes the use of formulas, and tables of sines and tangents easily understood without a knowledge of the higher mathematics.

25 Cents a Copy—Postpaid.

THE INDUSTRIAL PRESS, 140 LAFAYETTE STREET NEW YORK CITY

Machinery's Product Index



PERFECT RIVET HEADS ON SHUSTER RIVETERS

A Shuster Riveting Machine delivers a rotary blow, of just the right intensity, in just the right spot, every time. There's no work bent or broken in assembling when the Shuster Riveter is on the job.

That's one of the reasons why the Dayton Engineering Laboratories Company uses eight of these machines. Not only is output high class, but costs are low—and this is the best of reasons why you should investigate.

May we give you some of the facts? Ask for Catalogue R.

THE F. B. SHUSTER CO.
NEW HAVEN, CONNECTICUT

STRAIGHTENERS and CUTTERS for ROUND WIRE, SQUARES, HEXAGONS, Etc.

Hydraulic Accumulator with Pump and Tank

Constant Pressure with Valve Control

We furnish Accumulators in various sizes to suit constant and variable pressure systems.

BUILT BY

The Waterbury Farrel Foundry & Mch. Co.
Waterbury, Conn.

Western Office:
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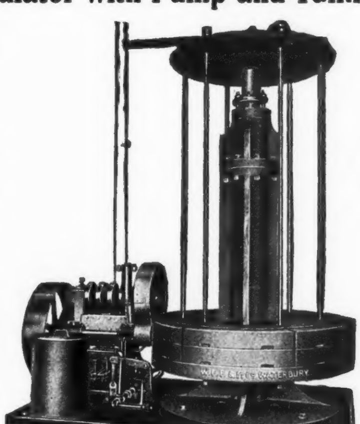
Cleveland, O.



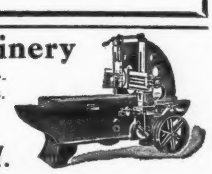
Hydraulic Accumulator (2848)

Automatic and Special Machinery

of all kinds designed and built. Inventions perfected. Builders of Variable Speed Iron Planers. Correspondence Solicited.

Engineers and Machinists.

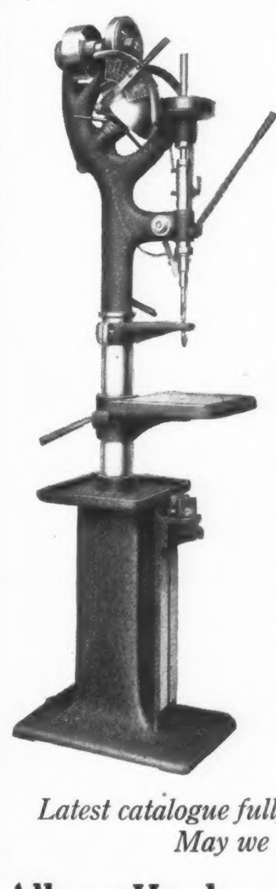
THE W. A. WILSON MACHINE CO., Rochester, N. Y.



CINCINNATI LATHES

have none of the complicated mechanism that means endless repairs and short-lived efficiency. Years of actual service is the test behind every part. Every stud and shaft in our Double Wall Apron is supported at both ends to withstand any cut. Give us an opportunity to prove to you too the merits of our specialty.

THE CINCINNATI LATHE & TOOL CO.
OAKLEY, CINCINNATI, OHIO, U. S. A.

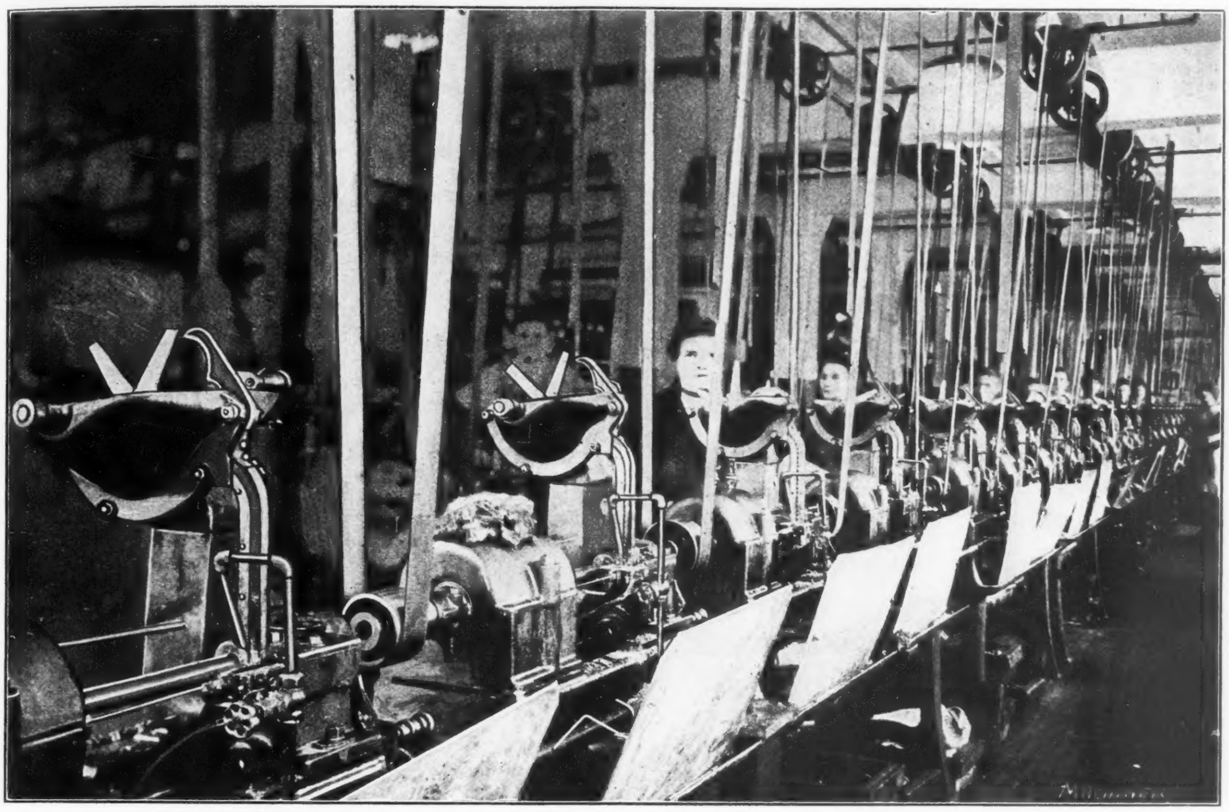


Don't Waste Time Figuring

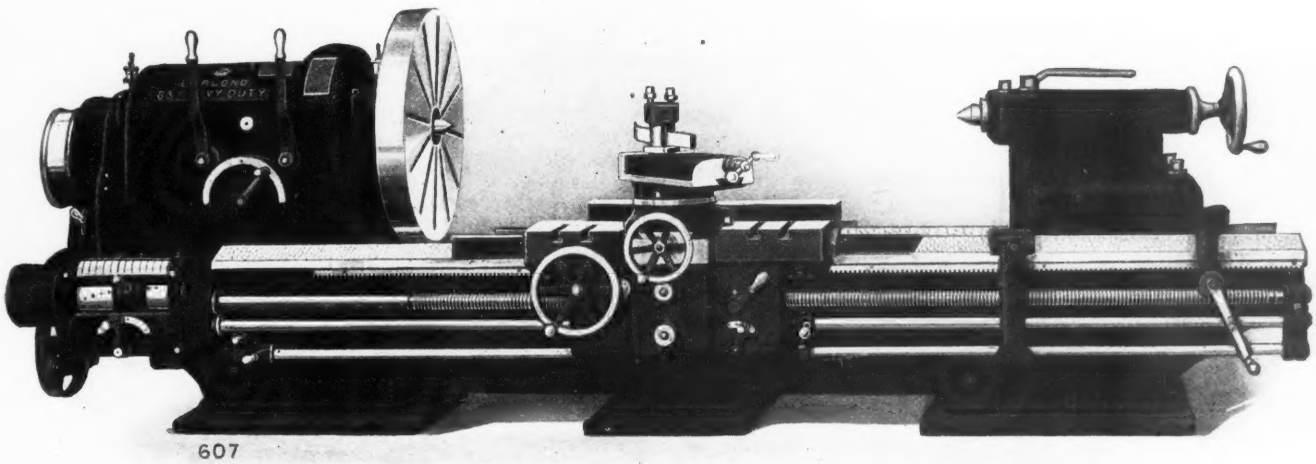
The index table tells at a glance just the right speed to run an "Albany" High Speed Drilling Machine. The micrometer depth gauge tells when the hole has been drilled deep enough, and the special friction drive is very practical. Prominent among "Albany" features are: "Rapidity of stopping and starting the spindle; speed with which drills and chuck can be changed, and closest accuracy when drilling to the correct depth.

Latest catalogue fully describes the machine. May we mail a copy?

Albany Hardware Specialty Mfg. Co.
ALBANY, WISCONSIN, U. S. A.



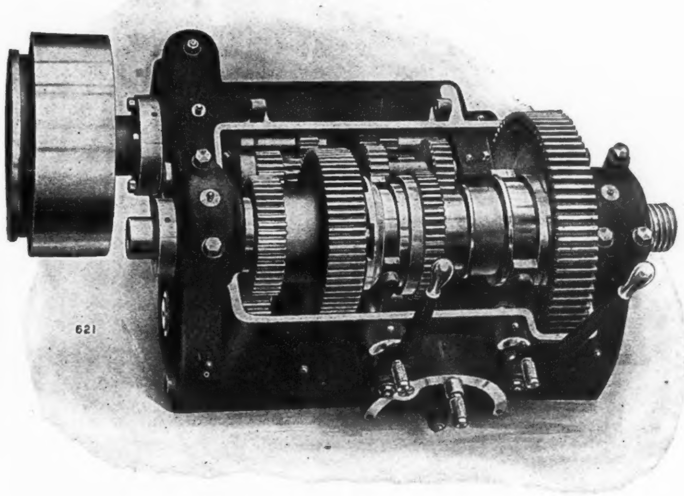
IT IS ONLY LOGICAL THAT LeBLOND HEAVY DUTY LATHES PRODUCE MORE WORK



LeBLOND 30-INCH HEAVY-DUTY LATHE WITH SINGLE PULLEY DRIVE GEARED HEADSTOCK

They Produce More Work Because They Are Built For It

The powerful geared headstock, the single piece box section apron with only seven gears (all drop forged), the patent compensating vee bed section with twice the carriage bearing surface found on any other lathe of the same size, are factors—big factors—in determining production.



INTERIOR VIEW OF HEADSTOCK

THE HEADSTOCK

The headstock is simply an automobile transmission in principle, carried out several steps and back geared to provide twelve changes of speed. The sliding gears and their mates, as well as the jaw clutches, are three and one-half per cent nickel steel, heat treated, with strengthened stub form teeth; in other words, practically indestructible. The shafts are short and rigidly supported, the driving power is tremendous—all that the modern tool steels can utilize. The changes are made instantly by the simple movement of three levers conveniently placed, while the spindle is started and stopped from the apron, introducing a new degree of convenience.

If you need a Lathe at all, you can't afford to overlook the LeBlond heavy duty.

THE R. K. LeBLOND MACHINE TOOL COMPANY, Cincinnati, Ohio

DOMESTIC AGENTS: Niles-Bement-Pond Co., Birmingham, Ala., Boston, Mass.; Chicago, Ill.; New York, N. Y.; Philadelphia, Pa.; Pittsburgh, Pa.; St. Louis, Mo. Caldwell Machinery Co., Seattle, Wash.; Tacoma, Wash. Eccles & Smith Co., Los Angeles, Cal.; Portland, Ore.; San Francisco, Cal. Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo. Cleveland Tool & Supply Co., Cleveland, O. J. L. Osgood, Buffalo, N. Y. E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind. Rumely Wachs Machinery Co., Chicago, Ill. F. E. Satterlee Co., Minneapolis, Minn. Oliver H. Van Horn, New Orleans, La. C. C. Wormer Co., Detroit, Mich.
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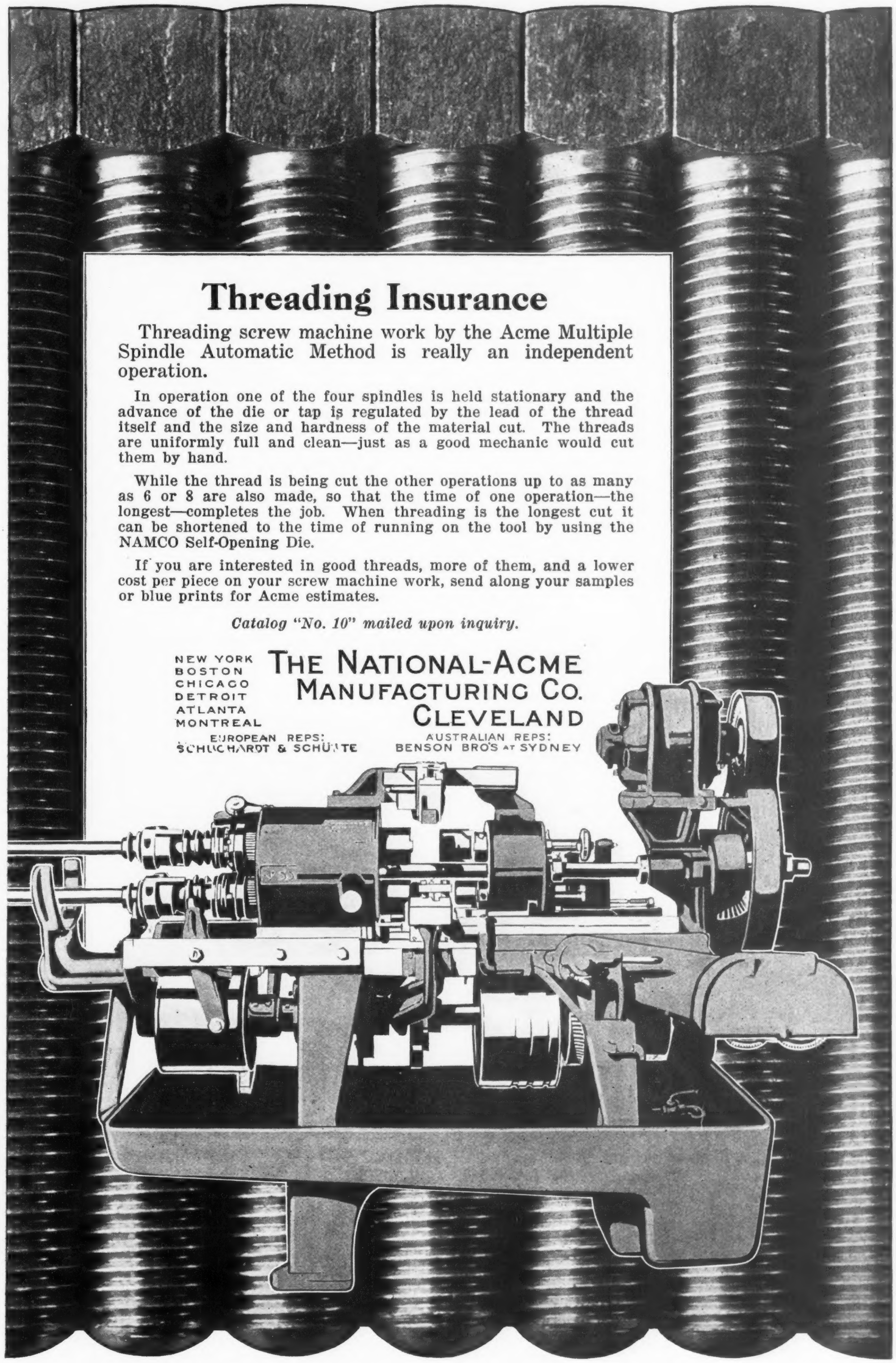
Threading Insurance
Threading screw machine work by the Acme Multiple Spindle Automatic Method is really an independent operation.
In operation one of the four spindles is held stationary and the advance of the die or tap is regulated by the lead of the thread itself and the size and hardness of the material cut. The threads are uniformly full and clean—just as a good mechanic would cut them by hand.
While the thread is being cut the other operations up to as many as 6 or 8 are also made, so that the time of one operation—the longest—completes the job. When threading is the longest cut it can be shortened to the time of running on the tool by using the NAMCO Self-Opening Die.
If you are interested in good threads, more of them, and a lower cost per piece on your screw machine work, send along your samples or blue prints for Acme estimates.
Catalog "No. 10" mailed upon inquiry.
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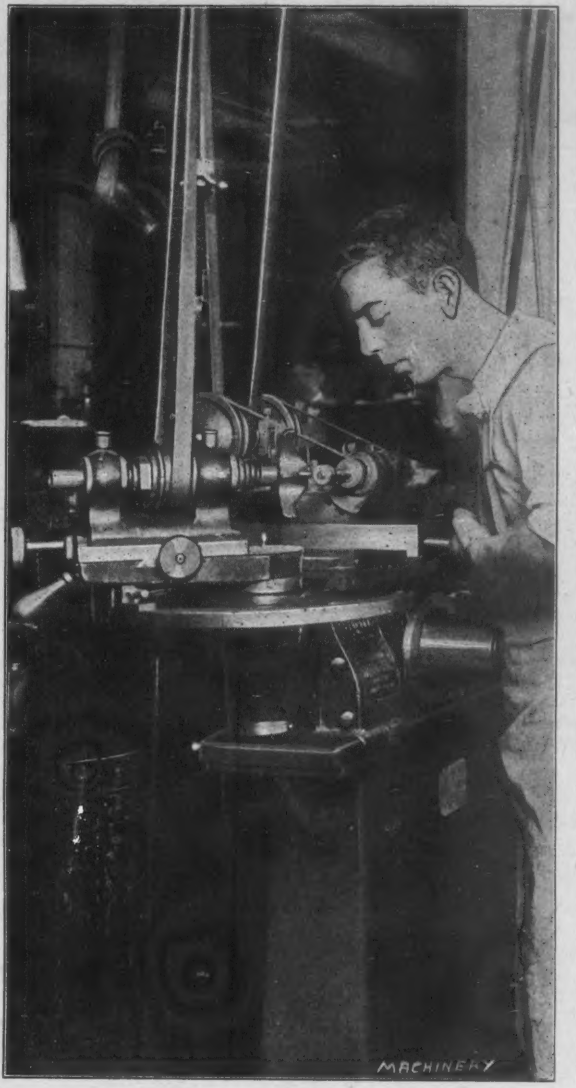
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